SHOUT
SHARE
IT

LIBRARY
OF THE
UNIVERSITY
OF ILLINOIS

580.5
FB
v.9

BIOLOGY

AMERICAN
MUSEUM
HISTORY

JUN 30 1944

STUDIES OF THE VEGETATION OF MISSOURI—I

NATURAL PLANT ASSOCIATIONS AND SUCCESSION IN THE OZARKS OF MISSOURI

BY

JULIAN A. STEYERMARK

ASSISTANT CURATOR OF THE HERBARIUM, DEPARTMENT OF BOTANY

THE LIBRARY OF THE
JAN 22 1941
UNIVERSITY OF ILLINOIS

BOTANICAL SERIES
FIELD MUSEUM OF NATURAL HISTORY
VOLUME IX, NUMBER 5
DECEMBER 31, 1940

PUBLICATION 485

PRINTED IN THE UNITED STATES OF AMERICA
BY FIELD MUSEUM PRESS

F B
1.95

CONTENTS

PAGE

List of Illustrations 351

Introduction 353

Natural Plant Associations and Succession in the Ozarks of Missouri . 353
I. Sugar maple–bitternut hickory association 358
II. Sugar maple–white oak association 372
III. Oak–hickory association 387
IV. Oak–pine association 393
V. White oak–red maple association 397

Subclimax Stages in the Ozarks 401

Plant Indicators of Acidity and Alkalinity 404

Ecological Variations Induced by Burning, Logging, Clearing, and Other Unnatural Causes 408

Examples Taken from Specific Areas Showing Particular Stages within an Association 421

LIST OF ILLUSTRATIONS

TEXT FIGURES

PAGE

9. *Salix longipes–Hamamelis vernalis* associes on gravel bar at mouth of Indian Creek and White River, near Baxter, Stone County 359
10. *Salix longipes* associes on gravel bar, four miles northeast of Waynesville, Pulaski County 360
11. *Dianthera americana* forming dominant herbaceous growth along gravel bar on Bourbeuse Creek at Glaser Ford, three and one-half miles southwest of Bem, Gasconade County 361
12. *Salix nigra*, instead of *Salix longipes* var. *Wardii*, pioneering on gravel. Along Moreau River two miles southeast of Jefferson City, Cole County 362
13. Deposit of muddy alluvium above sand on bar on Little North Fork of White River, one and one-half miles south of Theodosia, Ozark County . 363
14. *Acer saccharinum–Populus deltoides* associes on right side behind gravel bar, between Reed Springs and Viola, Stone County 364
15. *Ulmus americana–Fraxinus pensylvanica* var. *lanceolata* associes on alluvium of valley along Jacks Fork of Current River, north of Monteer, Shannon County 365
16. Along Huzzah Creek, two miles southeast of Davisville, Crawford County. 371
17. Limestone glade along Niangua River, two miles south of Corkery, Dallas County 372
18. Limestone glade with dominants of *Silphium laciniatum*, *Psoralea tenuiflora*, and *Bouteloua curtipendula* on bluffs along Osage River, two miles northwest of Wisdom, Benton County 373
19. Red cedar glade or bald on dolomitic limestone, near Taney County line, in Stone County 374
20. Bald knob west of Table Rock, west of Branson, Taney County 375
21. *Diospyros virginiana* initiating woody growth on limestone glade along Niangua River, two miles south of Corkery, Dallas County. 376
22. *Quercus Muhlenbergii* invading an associes with *Diospyros virginiana* and *Bumelia lanuginosa* along the bluffs of Osage River (Lake-of-the-Ozarks), at Riverview, Morgan County 377
23. *Quercus Muhlenbergii–Fraxinus americana* associes dominating grassy slopes along headwaters of Bryant Creek, two miles southeast of Cedar Gap, Wright County 378
24. Bald knob, east of McClurg, Ozark County 379
25. Similar to Fig. 24, three miles northwest of Vichy, Maries County, except that forest of *Acer saccharum–Quercus alba* associes has more nearly closed the originally open glade 380
26. *Acer saccharum–Quercus alba* climax associes well developed over a limestone substratum, Taney County 381
27. Bluffs along White River just west of Shreiner's Ferry, Barry County . 382
28. Bee Bluff, along Current River, northeast of Eminence, Shannon County . 383
29. Bee Bluff, along Current River, northeast of Eminence, Shannon County . 385
30. Limestone bluffs along Eleven Points River, near mouth of White Creek, Oregon County 386
31. A typical Ozark landscape, south of Harley, Barry County 388
32. Porphyritic trachyte glade of Red Rock Mountain, near Irondale, Washington County 389

PAGE

33. *Rhus Copallina* invading prairie habitat, one mile from Riverview bluffs, Morgan County 390

34. Upland woods with dense, grassy cover near head of Mud Creek, twelve miles north of Poplar Bluff, Butler County 391

35. An oak–hickory associes on a flat upland near Dillard, Crawford County . 392

36. *Pinus echinata* developed in almost pure stand on Pine Bluff, overlying Roubidoux sandstone along Meramec River, four miles south of St. Clair, Franklin County 394

37. Pure pine stand on ridge top north of Bunker, Reynolds County . . . 395

38. South-facing limestone bluffs along White River opposite Table Rock, Taney County 399

39. Right half of picture in background in white is covered by *Juniperus virginiana* overlying a limestone substratum; left half of picture mixed oak and pine overlying chert substratum. Along highway No. 19, two miles north of Eminence, Shannon County 400

40. Right half of picture in background in white is covered by *Juniperus virginiana* overlying a limestone substratum; left half of picture mixed oak and pine overlying chert substratum. Along highway No. 19, two miles north of Eminence, Shannon County 402

41. Effect of a spring burn, showing a very light density of forest floor coverage. Note the open patches of soil between the herbs. Twelve miles north of Poplar Bluff, Butler County 409

42. Damage done by summer burn, along highway No. 49, just south of Black, Reynolds County 410

43. Damage done by summer burn, along highway No. 49, just south of Black, Reynolds County 411

44. Flat ridge top in *Quercus alba–Quercus stellata* woodland, four miles northwest of Bunker, Reynolds County 413

45. *Quercus alba–Quercus velutina–Quercus stellata* woodland on flat ridge top, four miles northwest of Bunker, Reynolds County 414

STUDIES OF THE VEGETATION OF MISSOURI—I

JULIAN A. STEYERMARK

INTRODUCTION

The present paper is the result of observations and records made by the author while collecting and making a systematic study of the flora of Missouri during the past fifteen years. He does not profess to be a trained ecologist in the modern usage of that term. As a taxonomist who, in making a systematic study of the flora, has collected in every county of the state in order to make the thorough phytogeographical survey that was necessary to the understanding of the distribution and limitations of species and varieties, he has observed, collected, and recorded the flora found in every conceivable type of association (in the usual sense employed for this expression) in the state. Specimens of all the plants mentioned in the present paper may be found in the Herbarium of the Missouri Botanical Garden and in the Herbarium of Field Museum. Such specimens form a concrete and definite basis for the observations made in this paper. Moreover, they serve as the only tangible evidence whereby the statements made by the author may be verified or refuted.

The terms "association," "consociation," "associes," "society," "climax," and "dominant" used in the present paper are to be applied in the ordinary and usual sense in which they are employed generally by ecologists in the United States, and agree with the concept of these terms as originally given by Warming,[1] Weaver and Clements,[2] and many others. The 164 examples given at the end of the paper represent actual areas of ground surveyed in detail by the author in making observations within the Ozarks. They may be considered as large-scale, natural plots selected because they represent typical cross sections which occur in diverse areas within the Ozark region.

NATURAL PLANT ASSOCIATIONS AND SUCCESSION IN THE OZARKS OF MISSOURI

Some of the stages of succession noted here will be found in parts of the state other than the Ozarks, for example, in the glaciated

[1] E. Warming, Oecology of plants. 422 pp. Clarendon Press, Oxford, England. 1909.

[2] J. E. Weaver and F. E. Clements, Plant ecology. 520 pp. McGraw-Hill Book Company, New York. 1929.

prairie region north of the Missouri River and outside the Ozarks, or in the southeastern lowland area, or in the unglaciated prairie region of west-central and southwestern Missouri.

Attention should be called to the fact that the past and intricate geological history of the Ozark region has been one of the chief factors in causing the migration and present distributional status of many of the species. For example, the present distribution of the bald cypress and other southeastern lowland species in Missouri is delimited by the incursion of the Mississippi embayment in past geological periods. Again, the present northern and northwestern limits of the southern yellow pine and species with similar distribution in the Ozarks of Missouri do not result primarily from any factors of the soil or climate of the present, since similar conditions are encountered in northern Missouri, but rather from factors of past geological history, such as the extermination by glaciers of the Ozark flora north of the Ozark region, or a climatic disturbance causing a block or change in migration, or elimination of habitats previously suitable to the species but now exterminated north of the Ozark region.

The Ozark flora is an extremely varied one, and its composition has been made much more intricate and complex by the uplifts and peneplanations of the land, varied rock formations, and long history as a land area since the end of the Paleozoic era. This accounts for the great number and variety of stages of development within a given plant association.

Reference is here made to *Plant ecology* by Weaver and Clements. It will be found that a number of conclusions reached in this report differ in some ways from those made in that publication. The reasons for this are several. In the first place, no critical study of the natural plant successions in the Ozark flora has previously been attempted. Thus, while some general statements in Weaver and Clements' book hold true, a number of large generalizations made in that work to cover the region in which the Ozarks are located, concerning climax formations and associations, do not hold. Further than this, these authors, by stressing the physical factors of the soil, have not sufficiently considered variations in the chemical nature of the soil or the past geological history of the region as factors which might cause different stages in development of an association or account for the appearance of certain consocies and dominants. Thus, for example, the maple–beech forest is regarded by them as a typical association of the deciduous forest climax formation; but, in Missouri, this

formation is found only in the southeastern portion, and mainly on Crowleys Ridge, the beech being limited to this part of the state on account of the past geological history and the meanderings of the Mississippi River and the relation of this to the Crowleys Ridge area. The beech could, on the basis of soil and climatic conditions and its shade tolerance, grow farther west where the maple is found, but past geological history has restricted it to its present area. In the Ozarks the sugar maple (*Acer saccharum*) forms a climax with some of the oaks (*Quercus alba* and *Q. borealis* var. *maxima*) along rich, wooded slopes and bluffs, rather than with beech. Furthermore, the sugar maple climax is not reached unless the soil ranges from neutral to alkaline, for where acid soils exist, other climax species, such as *Quercus coccinea* and *Pinus echinata*, are found. In the Ozarks the acidity of the soils plays an important part in causing different stages and units of succession, and many of the associes owe their appearance in the development of the vegetation to the particular stage of substratum decomposition or formation. Thus, in the Ozarks, the basis for the appearance and difference in the oak–hickory or pine–oak association on the one hand and the sugar maple association on the other, lies in the acidity and chemical nature of the soil, rather than, as Weaver and Clements maintain, in the physical or moisture condition of the soil. The limiting factor, in other words, appears to be the presence or absence of limestone, rather than soil moisture and shade. This will be discussed further in this paper.

In Missouri different types of soils within a limited region appear to result in entirely different associations and climaxes. For so limited an area this conclusion is at variance with the single climax type admitted for the region included within the Ozarks by Weaver and Clements. However, some of the Old World ecologists appear to confirm the conclusions reached by the present author. Du Rietz,[1] for example, points out that "contrary to the monoclimax theory developed by Clements and Braun-Blanquet, I find it necessary, however, to maintain the polyclimax theory developed by Domin, Gams, Gleason, Nichols, Nordhagen, Scharfetter, Tansley, myself, etc., i.e., to admit that several climax-phytocoenoses—in many cases with very little relationship to each other—may occur side by side in the same vegetation region, but in edaphically different habitats. . . . My own field experience certainly does not support the theory of the power of a uniform climate to transform all these edaphically different habitats into one comparatively uniform 'climax-habitat' ('climax-

[1] G. Einar du Rietz, Classification and nomenclature of vegetation. Svensk. Bot. Tidskr. 24, H. 4, p. 497. 1930.

soil,' etc.), as postulated by the monoclimatic theory." The author continues his discussion by showing that in various places in Europe many climaxes are developed in the same region. He states[1] that "in the *Quercus* region of south Sweden, for instance, certainly both *Quercus* forests and *Picea–Pinus* forests, among others, must be admitted as climax-phytocoenoses, the former on better and the latter on poorer soils. In the case of the alpine vegetation regions of the Alps and of Scandinavia, there is a complete agreement among Scandinavian ecologists that the dominating dwarf–shrub–heath and grass–heath of the acid and moderately snow-covered ground in the low-alpine and middle-alpine belts respectively, are by no means the only climax-phytocoenoses of these regions as assumed by Braun-Blanquet. Parallel with them there also occur not only subneutrophilous (pH 5.5–7) and neutrophobous climax phytocoenoses both chionophobous (on wind-exposed ridges) and chionophilous (on snow-loving, i.e. 'Schnee-boden' communities), consisting of grass, herb, dwarf-*Salix*, moss, and lichen communities very different from the dominant subchionophobous heath."

Tansley[2] states that "the so-called 'polyclimax theory' takes what appear to be permanent types of vegetation under given conditions and calls them climatic conditions of the region and on the most favorable soils the climatic climax is reached by the succession; but that on less favorable soils of special character different kinds of stable vegetation are developed and remain in possession of the ground, to all appearances as permanently as the climatic climax. These are called *edaphic* climaxes, because the differentiating factor is a special soil type." Other climaxes are described, caused by physiography, grazing, fire, and mowing. Of these he says,[3] "In each case the vegetation appears to be in equilibrium with all the effective factors present, including of course the climatic factors, and the climax is named from the special factor differentiating the vegetation from the climatic climax. . . . The word climax is used in its simple and natural signification of a culmination of development—a permanent or apparently permanent condition reached when the vegetation is in equilibrium with all the incident factors." Speaking of the relation of soil on succession, Tansley states[3] that while it is simple to believe that "the soil profile runs *pari passu* with the development of the vegetation it bears, and that consequently the

[1] Ibid., p. 499.

[2] A. G. Tansley, Vegetational concepts and terms. Ecology 16: 292. 1935.

[3] Ibid.

mature climatic soil type corresponds and co-exists with the climatic climax community," yet he goes on to state that this is not true, because "even when profile development under the influence of climate is perfectly normal and regular, the climatic climax community may establish itself long before the soil is mature, and may not be substantially altered by the later stages of profile maturation. Again a climatic climax may establish itself on a soil which is kept immature by geological and geographical causes, as on a steep slope. *And finally it is now generally agreed by pedologists that some rocks, owing to the simplicity of their composition, produce soils which can never form the normal climatic mature profile, and these may or may not bear the typical climatic climax vegetation.*" (The italics are the present author's.)

The field experience of the author in his observations on the Missouri flora is in full agreement with the statements quoted above by du Rietz and Tansley. The Ozarks offer a wonderful example in soil diversities and give ample opportunities of corroborating the opinions of these ecologists concerning the influence of soils on the various types of vegetation within a small region. Thus, we find that on the acidic substrata of chert, sandstone, or granitic rock an associes culminating in oak, hickory, southern yellow pine, *Acer rubrum, Nyssa sylvatica* var. *caroliniana,* and *Cornus florida* is as characteristic a climax association as is that of *Acer saccharum, Quercus Muhlenbergii,* and other species developing on a limestone soil. The fact that several climaxes may exist in the Ozarks is proven by these permanent, well-marked associations which have originated from different substrata, yet may exist, as they often do, contiguous to each other. The fact remains that they are not climatic climaxes, as argued by Weaver and Clements, because the climate has not differentiated these diverse, stable associations, one on limestone, the other on chert, sandstone, or porphyritic trachyte or granite. Rather, these climaxes are edaphic and owe their diversity to their separate selections of soil conditions.

Friesner and Potzger[1] concluded, after a study of certain areas in Indiana in which soil reactions between the *Fagus–Acer* and *Quercus–Carya* communities were compared, that "the range of reaction in surface soils for beech–maple does not show much difference from that of oak–hickory, except that the reaction spread is a little nearer alkalinity in beech–maple, extending from pH 4.5 to 7.53, and a little

[1] Ray C. Friesner and J. E. Potzger, Contrasts in certain physical factors in *Fagus–Acer* and *Quercus–Carya* communities in Brown and Bartholomew counties, Indiana. Butler Univ. Bot. Stud. 4: 8–9. 1937.

more acid in oak–hickory, extending from pH 4.1 to 7.24. . . . The majority of the soil samples gave a decidedly more acid reaction for oak–hickory than was found in any of the beech–maple areas except one. It will also be seen that while the oak–hickory range exhibits as wide a spread as the beech–maple, the majority of the samples fall within a much narrower range which is more acid than the majority of the readings for the beech–maple soils." As will be shown in the following portion of this paper on plant associations in the Ozarks, the oak–hickory association develops upon an acid substratum, while *Acer saccharum* develops from a limestone substratum and *Acer rubrum* from an acidic cherty, sandstone, or granitic or porphyritic trachyte substratum.

In Weaver and Clements' *Plant ecology*, three associations, i.e., the oak–hickory association, maple–beech association, and oak–chestnut association comprise the three associations in the deciduous forest climax formation, while in this report five associations are described.

The climax formation in the Ozarks is a mesophytic forest. The climate is of the type which effects such a mesophytic development. This mesophytic climax forest is made up of various associations.

Units for discussion in the Ozarks have arisen from the following sources: (1) stages in flood-plain formation; (2) ridge tops and plateau areas; (3) ravines and upper drainage heads of the tributaries in acid soil areas; and (4) stages in cover over an eroded limestone bluff or open glade. Some of these associations, therefore, depend on the type of rock substratum from which they start. Thus, the development or succession of the vegetation is closely correlated with the type of rock in the particular area under discussion.

The five associations included within this climax formation are: (I) sugar maple–bitternut hickory association; (II) sugar maple–white oak association; (III) oak–hickory association; (IV) oak–pine association; and (V) red maple–white oak association.

I. SUGAR MAPLE–BITTERNUT HICKORY ASSOCIATION

(*Acer saccharum–Carya cordiformis*)

(1) The first association, the sugar maple–bitternut hickory (*Acer saccharum–Carya cordiformis*) association, is the climax stage reached from a development of the flood-plain flora. The developmental stages or associes of this association are definitely correlated with the development and maturity of the stream. Most of the smaller Ozark streams are still in some stages of youth and conse-

quently are dashing and swift-flowing types, carrying loads of chert which have been eroded and borne from the hills. At the stage when the stream is still small and youthful, with a rocky bed loaded with gravel deposits, occurs the first developmental stage, the Ward willow–witch hazel (*Salix longipes* var. *Wardii–Hamamelis vernalis*) associes. This shrubby willow pioneers with the witch hazel along all the smaller, rock-laden streams or along the gravel bars or rocky deposits of streams which are in a more mature stage of development (fig. 9). In the northern and western border of the Missouri Ozarks, in much of the area of the Niangua, Osage, lower Gasconade,

FIG. 9. *Salix longipes–Hamamelis vernalis* associes on gravel bar at mouth of Indian Creek and White River, near Baxter, Stone County.

and Pomme de Terre rivers, the witch hazel is absent, leaving Ward's willow as the sole dominant of the first stage of the flood-plain association (fig. 10). Witch hazel is found all over the eastern and southern Ozarks.

Sycamore (*Platanus occidentalis*) is always a conspicuous member (consocies) of the willow–witch hazel associes. It is particularly dominant on gravelly and sandy deposits. Along the gravel bars and sandy deposits of the larger Ozark streams such as the Current River, Piney River, Gasconade River, Black River, White River, and others, it and Ward's willow are the pioneers, while alder and usually witch hazel are absent. Alder (*Alnus rugosa*) is often associated with the willow, witch hazel, and sycamore, but is commonest along the smaller tributaries and headwaters. These four species (Ward's willow, witch hazel, sycamore, and alder) make up the dominants or consocies. Sometimes the sand grape (*Vitis rupes-*

tris), ninebark (*Physocarpus opulifolius* var. *intermedius*), and *Cornus obliqua* are associated with these. Water willow (*Dianthera americana*) is a conspicuous herbaceous dominant in the willow–witch hazel associes and is found in dense colonies, rooting along the gravelly, shallower margins of most of the streams, especially the smaller ones (fig. 11). Chairmakers' rush (*Scirpus americanus*) is often associated with water willow on gravelly areas.

FIG. 10. *Salix longipes* associes on gravel bar, four miles northeast of Waynesville, Pulaski County.

Many of the extensive gravel bars may be covered with:

Ambrosia elatior var. *artemisiaefolia*
Ambrosia trifida
Amsonia illustris
Commelina erecta
Cyperus esculentus
Cyperus inflexus
Desmodium sessilifolium
Digitaria sanguinalis (common)
Diodia teres
Eragrostis hypnoides
Eragrostis pilosa
Euphorbia corollata
Euphorbia maculata
Euphorbia supina
Hemicarpha micrantha
Ipomoea hederacea
Lespedeza capitata
Lespedeza virginica
Leucospora multifida
Lindernia dubia var. *major*
Mollugo verticillata
Oxalis stricta
Panicum virgatum (common)
Polygonum lapathifolium
Polygonum pensylvanicum
Rorippa islandica var. *microcarpa*
Xanthium pensylvanicum

The above gravel bar species may be expected to occur on most gravel bars along the streams, the amount of sand on the one extreme and muddy alluvium on the other changing materially the aspect of the composition of the flora.

(2) Farther away from the margin of the rocky stream a richer soil is gradually built up by successive alluvial deposits (fig. 13).

A new associes of silver maple–cottonwood (*Acer saccharinum–Populus deltoides*) develops here. Other dominants (consocies) usually found with silver maple and cottonwood are river birch (*Betula nigra*), black willow (*Salix nigra*), and buttonbush (*Cephalanthus occidentalis*) (fig. 14). As the silver maple–cottonwood associes gradually gains possession of the better soil, witch hazel disappears, but sycamore and Ward's willow of the preceding associes persist into this new succession. Instead of cottonwood with silver maple, as in the southeastern Missouri Ozarks, one finds green ash (*Fraxinus pensylvanica* var. *lanceolata*) in the western Ozarks along

FIG. 11. *Dianthera americana* forming dominant herbaceous growth along gravel bar on Bourbeuse Creek at Glaser Ford, three and one-half miles southwest of Bem, Gasconade County. Note *Salix longipes* var. *Wardii* immediately behind *Dianthera* colony.

the Gasconade River, where cottonwood is quite rare. In the southeastern Ozarks local species such as *Liquidambar Styraciflua* diversify the alluvial formation, but along the Gasconade River there are no unusual species diversifying the area. Along the Gasconade River, *Hamamelis vernalis* is rare and local. On Piney River the very infrequent cottonwood is associated with silver maple and green ash.

The silver maple–cottonwood associes may completely succeed the willow–witch hazel associes if the rocky stream habitat of the latter becomes covered over with a rich alluvium favorable for the development of the former associes, or the two associes may exist as contiguous ones in relation to the alluvial formation of the stream.

The birch and the buttonbush sometimes come into the succession before the black willow, cottonwood, and silver maple have made

their appearance, and this may be explained by the greater ability of these two species to seed themselves in more gravelly and sandy stream bars. Along the Osage fork of the Gasconade River in Webster County, for example, river birch is absent as one of the associes of a later flood-plain succession. In this region Ward's willow and sycamore are dominant, being followed by black willow, silver maple, and green ash. On the Current River silver maple and poplar pioneer together as associate species in much the same way as they do in parts of areas of northeastern Missouri, as, for example, on Salt River.

FIG. 12. *Salix nigra*, instead of *Salix longipes* var. *Wardii*, pioneering on gravel. Along Moreau River, two miles southeast of Jefferson City, Cole County.

These first two associes of a flood-plain association are subject to sudden stream overflows and variation of water level. The herbaceous ground flora is, therefore, not varied, is late in developing, and is often composed of annuals or water-resistant types. There is practically no herbaceous or moss associes on the rocky habitat of the willow–witch hazel associes, but where a relatively large area of alluvial ground exists, with the silver maple–cottonwood associes are found a few dominant species on the forest floor, such as *Pilea pumila* var. *Deamii*, *Aster lateriflorus* var. *pendulus*, *Rudbeckia laciniata*, and white grass (*Leersia virginica*). Such mosses as *Amblystegium riparium* and *Leskea gracilescens* may be present.

After this stage of the flood-plain has been reached, the succession, once the deposit of alluvium has been formed, proceeds at a faster rate and more quickly reaches the climax types.

(3) The next stage, associated with the formation of richer soil over the original alluvium, is the American elm–green ash (*Ulmus americana–Fraxinus pensylvanica* var. *lanceolata*) associes (fig. 15). Sometimes, in places along the border counties of the Ozarks, *Fraxinus pensylvanica* var. *lanceolata* may pioneer on gravel bars with *Salix Wardii*, sycamore, and *Cephalanthus*—as on the Osage River in St. Clair and Benton counties. Another dominant in this phase of the succession is *Quercus Shumardii* (locally called water oak, otherwise named Shumard's red oak). Along Current and Black rivers, *Quercus Shumardii* is common in the *Ulmus americana–Acer saccharinum–Fraxinus pensylvanica* var. *lanceolata* formation, but on Gasconade and Piney rivers it is quite absent most of the time and found only occasionally. Bur oak (*Quercus macrocarpa*),

FIG. 13. Deposit of muddy alluvium above sand on bar on Little North Fork of White River, one and one-half miles south of Theodosia, Ozark County. Shows how a sand bar is gradually built up with a consequent new associes developing upon it.

box elder (*Acer Negundo*), and a few others also make their appearance in this stage, and in parts of the southeastern Ozarks, as along the Black and St. Francis rivers, sweet gum (*Liquidambar Styraciflua*) is found sometimes in this associes. The herbaceous associes on the forest floor is somewhat more varied than in the last associes, but stream overflows continue to occur in this associes likewise. Such herbs as honewort (*Cryptotaenia canadensis*), Virginia knotweed (*Polygonum virginianum*), beefsteak plant (*Perilla frutescens*), *Iresine rhizomatosa*, and *Calycocarpum Lyoni* are common, while the grass flora is dominated by spike grass (*Uniola latifolia*), fowl meadow

grass (*Glyceria striata*), giant cane (*Arundinaria gigantea*), and satin grass (*Muhlenbergia mexicana*). Along alluvial limestone banks at the base of bluffs, as along the Osage River in St. Clair County and elsewhere, *Uniola latifolia* and *Panicum virgatum* are dominant, associated with *Apocynum sibiricum* and *Leptochloa filiformis*. This is equivalent to pioneers on a mud stage, discussed under previous alluvial forms.

FIG. 14. *Acer saccharinum–Populus deltoides* associes on right side behind gravel bar, between Reed Springs and Viola, Stone County.

No *Arundinaria gigantea* occurs along the Gasconade, Osage, Piney, Meramec, Big, and Niangua rivers or their tributaries in the elm–ash stage or in other stages. The *Arundinaria* begins to appear on Black, Current, and other rivers where shaded alluvial banks and thickets occur. *Smilax Bona-nox* together with *Arundinaria* is common along the banks of White River.

After the third developmental stage (i.e. the American elm–green ash associes) has been attained, Ward's willow and buttonbush, more or less shade-intolerant types, disappear, but sycamore, cottonwood, and black willow persist. In many alluvial associations in the western Ozarks, however, no cottonwood is present. Sometimes sugar maple also appears in the elm–ash associes, but does not become dominant until the last stage of the associes. This elm–ash associes may last indefinitely, and in some regions where the soil is flooded frequently and worn away or where the surrounding soil types are too acid, sugar maple may be prevented from entering this associes, and the elm–ash associes may become a temporary climax or subclimax.

Sometimes, in the Gasconade River region, silver maple and green ash together with sycamore are followed by birch–elm–ash–sycamore with maple, the two intergrading and slightly different from the situation which occurs in the southeastern Ozarks, where silver maple, cottonwood, and birch are often followed by elm and green ash, with birch, sycamore, and maple lingering over into the newer associes.

FIG. 15. *Ulmus americana–Fraxinus pensylvanica* var. *lanceolata* associes on alluvium of valley along Jacks Fork of Current River, north of Monteer, Shannon County. On top of the bluffs on the right are pine trees occurring on cherty and Roubidoux sandstone substrata.

In the southeastern Ozarks the usual succession is:

(1) Ward's willow, witch hazel, sycamore, alder; succeeded by
(2) silver maple, poplar, birch, black willow; succeeded by
(3) elm, green ash.

In the White River country it is:

(1) Ward's willow, witch hazel; succeeded by
(2) black willow; succeeded by
(3) silver maple, birch, elm, green ash.

In the Gasconade River area it is:

(1)Ward's willow; succeeded by
(2) sycamore, black willow; succeeded by
(3) silver maple, green ash, birch; succeeded by
(4) elm, silver maple.

But the end result is in all cases usually the same, i.e. with elm, silver maple, and green ash comprising the dominants in the associes. The elm comes in last in each case, but may have ash with it first or last, the ash being the varying pioneer.

Variations in Stage No. 3:

(*a*) On Piney Creek and other areas in Table Rock National Forest Purchase Unit in Barry and Stone counties, southwestern Missouri, instead of alder occurring with witch hazel in stage No. 1, *Ilex decidua* is found with witch hazel. The latter two plants are the dominants, together with such species as *Ostrya virginiana, Cornus obliqua, Cornus asperifolia,* and *Physocarpus opulifolius* var. *intermedius* (example No. 5).

(*b*) On Table Rock National Forest Purchase Unit in the White River country of southwestern Missouri, swamp privet (*Forestiera acuminata*) in stage No. 3 is scattered and sometimes is frequent along the banks with a characteristic alluvial stage of ash, elm, birch, and silver maple; in later associations it is often found with *Carpinus caroliniana* along steep river slopes (example No. 31). This same condition occurs on the St. Francis River near Chaonia on the Wappapella National Forest Purchase Unit in southeastern Missouri.

(*c*) At the base of steep slopes in the Table Rock National Forest Purchase Unit of southwestern Missouri, *Hamamelis vernalis* is common, but is not the dominant on gravel bars as it usually is elsewhere, for example, in the eastern and southern Ozarks. Instead, *Salix Wardii* and *Platanus* dominate the gravel bars. This is of interest, because *Hamamelis* is absent also to the east, on the larger streams, but is present on the smaller ones.

(*d*) On the Niangua River, on the Little Pomme de Terre River, and on the Osage Fork of Gasconade River near Rader in Webster County, there is no birch, alder, or poplar in the alluvial formation. Instead, one finds that Ward's willow or Ward's willow and sycamore are followed by black willow and green ash, and then elm.

(*e*) On the Gasconade River, in stage 2, instead of sycamore and black willow as co-dominants, there are sycamore, black willow, sand-bar willow (*Salix interior*), birch, and *Ampelopsis cordata.* Birch may be entirely absent from the associes as, for example, along the Osage Fork of the Gasconade River in Webster County.

(*f*) In the southeastern Ozarks sycamore appears at the very beginning of the succession with *Salix Wardii* and witch hazel (examples Nos. 1, 2, 9, and 10), but on the Gasconade River sycamore follows *Salix Wardii* or *S. interior* and is usually mixed with black willow.

(*g*) Along the northern border of the Ozark region the black willow pioneers on the gravel at the very beginning of the succession instead of *Salix longipes* var. *Wardii.* The latter is here near its

northern limit of dispersal in the Ozarks and its place is taken by *Salix nigra* (fig. 12).

(*h*) Silver maple, elm, and green ash are usually associated at the end of the flood-plain succession in the Gasconade and Piney river areas.

Rosa setigera var. *tomentosa* is frequent along the river banks in all the areas. *Vitis cordifolia* and *V. cinerea*, especially the latter, are the common vines in this alluvial formation, but *Ampelopsis cordata* and *Parthenocissus quinquefolia* also occur frequently. *Aristolochia tomentosa* is common all along the Gasconade, Piney, Black, Current, and White rivers in the alluvial formation. Variations on the Gasconade River are found in the pioneering frequencies of either *Salix Wardii* or *S. interior*, the former pioneering on direct gravel, the latter where more sandy mud has accumulated instead of gravel. Both species may grow on the same river bar.

Thus far, we have discussed the succession only among the trees and shrubs of the various associes of the flood-plain formation (*Acer saccharum–Carya cordiformis* association). The herbaceous succession in this formation is:

(1) Water willow (*Dianthera americana*); succeeded by
(2) *Scirpus americanus* or *Sagittaria latifolia* in back of water willow; succeeded by
(3) *Leersia oryzoides* and *Echinochloa pungens*.

Associated with the above dominant species in stage No. 3 are:

Bidens polylepis
Panicum capillare
Panicum dichotomiflorum
Panicum Gattingeri
Polygonum pensylvanicum
Polygonum punctatum
Xanthium chinense
Xanthium pensylvanicum

On more sandy soil, *Scirpus americanus*, *Lobelia cardinalis*, and *Eupatorium coelestinum* occur directly behind water willow, while *Sagittaria latifolia* grows on more muddy soil behind water willow. *Rotala ramosior* var. *interior* is found usually on muddy alluvium. Sometimes along the border counties of the Ozarks, as along the Osage River in St. Clair County, occur on the muddy bar *Acnida tamariscina*, *Ampelamus albidus*, *Xanthium pensylvanicum* and *X. chinense*, *Echinochloa pungens*, *Polygonum coccineum*, *P. lapathifolium*, and others, *Lippia lanceolata*, *Lindernia dubia*, *Ammannia coccinea*, and *Leptochloa filiformis*. Just within the *Xanthium* formation or behind it is *Hibiscus lasiocarpus*. In shaded alluvium, back of *Xanthium–Leersia* association occur:

Acalypha rhomboidea
Ambrosia trifida
Eupatorium coelestinum
Impatiens biflora
Perilla frutescens
Pilea pumila var. *Deamii*
Polygonum punctatum
Verbena urticaefolia

Along the Osage River in Miller County water willow is followed by an association of the following herbaceous plants: *Setaria lutescens, Panicum virgatum, P. capillare, Polygonum pensylvanicum, Euphorbia supina* (*E. maculata* of authors), and *E. serpens.* Back of the gravel accumulates an alluvial deposit of muddy soil dominated by the following plants: *Xanthium chinense, Polygonum pensylvanicum, Spermacoce glabra, Euphorbia maculata* (*E. nutans* of authors), *Ipomoea lacunosa,* and *Panicum dichotomiflorum.*

The herbaceous element changes as one goes from an alluvial type of woods to one with a development of more humus on the alluvial bottoms and slopes. Thus, in stage No. 1 on the moist alluvial banks along the Gasconade River the dominant species are:

Stage No. 1

Agrostis perennans
Cinna arundinacea
Elymus virginicus
Leersia virginica
Muhlenbergia sp.

Associated with the species in stage No. 1 are:

Campsis radicans
Panicum clandestinum
Phlox divaricata var. *Laphamii*
Pilea pumila var. *Deamii*
Ruellia strepens
Solidago serotina
Spermacoce glabra
Symphoricarpos orbiculatus
Ulmus americana
Uniola latifolia (on Black River)
Viola papilionacea
Xanthium pensylvanicum

Elymus virginicus is a dominant species along the banks of streams in the White River country.

Stage No. 2, on higher but still flat, alluvial ground, consists of the following species, developed in a woodland consisting principally of silver maple and green ash:

Stage No. 2

Acalypha rhomboidea
Acer Negundo
(young plants)
Acer saccharinum
(young plants)
Aster lateriflorus var. *pendulus*
Benzoin aestivale
(occasional; young plants)
Bidens frondosa
Boehmeria cylindrica
Cinna arundinacea
Commelina virginica
Dicliptera brachiata
(occasional)
Echinocystis lobata
Fraxinus pensylvanica var. *lanceolata*
(young plants)
Impatiens biflora
Iresine rhizomatosa
Mimulus alatus
Perilla frutescens
(rare)
Polygonum punctatum
(occasional)
Polygonum virginianum
Quercus macrocarpa
(occasional; young plants)
Rudbeckia laciniata
Ruellia strepens
Sambucus canadensis
(occasional; young plants)
Scutellaria lateriflora
Smilax hispida
Solanum nigrum
Solidago serotina
Toxicodendron radicans
(young plants)
Vernonia altissima
Viola papilionacea
Vitis cordifolia

The species listed above are in the type of woods described for the silver maple–cottonwood associes of southeastern Missouri.

Beginning with stage No. 3, where the base of the slope begins with a richer, better-drained soil, the herbaceous flora changes to an abundant and luxuriant growth of the following species:

Stage No. 3

Amphicarpa bracteata
Asarum canadense
Asimina triloba
(young plants)
Blephilia hirsuta
Carya cordiformis
(young plants)
Cystopteris fragilis var. *protrusa*
Eupatorium purpureum
Eupatorium urticaefolium
Euonymus atropurpureus
(young plants)
Galium triflorum
Geum canadense var. *camporum*
Impatiens pallida
Laportea canadensis
Menispermum canadense
Parthenocissus quinquefolia
Phytolacca americana
Sanguinaria canadensis
Tilia glabra
(young plants)
Verbesina virginica
Viola eriocarpa var. *leiocarpa*
Viola striata

As the richer slopes are ascended into drier, rockier ground, there is a thinning out of alluvial species such as *Leersia virginica, Rudbeckia laciniata, Eupatorium coelestinum, Aster lateriflorus* var. *pendulus,* and *Pilea pumila* var. *Deamii.* Their places are taken by the following species:

Carex blanda
Carpinus caroliniana
(young plants)
Carya cordiformis
(young plants)
Celtis occidentalis var. *canina*
(young plants)
Circaea latifolia
Cystopteris fragilis var. *protrusa*
Dioscorea villosa
Fraxinus americana
(young plants)
Phlox divaricata var. *Laphamii*
Quercus alba f. *latiloba*
(young plants)
Quercus borealis var. *maxima*
(young plants)
Sassafras albidum var. *molle*
(young plants)
Scutellaria ovata
Symphoricarpos orbiculatus
(young plants)
Ulmus fulva
(young plants)
Verbena urticaefolia

On some slopes covered with talus at this stage the herbaceous cover is dominated by *Impatiens pallida, Hydrophyllum appendiculatum, Viola eriocarpa* var. *leiocarpa, Podophyllum peltatum, Circaea latifolia, Menispermum canadense,* and *Asarum canadense.* Farther up the talus, where rocks are nearer the surface and more plentiful, *Polymnia canadensis* is dominant and may cover the ground solidly for more than half the way up. *Staphylea trifolia* is the dominant shrub on the talus one-fourth to one-half the way up, while on the lower, richer slopes, as the final climax stage, *Carya cordiformis* is dominant. *Tradescantia Ernestiana* is one of the herbaceous dominants of the rich slopes in the region of White River and its

tributaries in southwestern Missouri, but is not found elsewhere in the state.

As the soil becomes richer and richer and gradually builds up a deeper humus layer mixed with rich, sandy alluvium, a greater number of trees, but particularly shade-tolerant shrubs, appear.

(4) This final developmental stage is dominated by sugar maple and bitternut hickory (*Carya cordiformis*), and the associes may be called the sugar maple–bitternut hickory associes. One or two understories of shrubs are usually found in this associes. The paw-paw (*Asimina triloba*) and American hornbeam or ironwood (*Carpinus caroliniana*) are dominant small trees forming an upper portion of the understory, while buck brush or coralberry (*Symphoricarpos orbiculatus*) is a dominant lower understory shrub. Flowering dogwood (*Cornus florida*) is often very abundant, as is also spicebush (*Benzoin aestivale*) and greenbrier (*Smilax hispida*). Along the tributaries of Black River, especially in the southeastern half of the Clark National Forest Purchase Unit, leatherwood (*Dirca palustris*) becomes a conspicuous shrub of the lower understory (examples Nos. 43 and 46). It is conspicuous also along Noblett and Indian creeks in Howell and Douglas counties. These creeks drain into the North Fork of White River in southern Missouri. Other trees and shrubs found commonly in the final stage of this flood-plain association are, in order of abundance:

Black walnut (*Juglans nigra*)
Chinquapin oak (*Quercus Muhlenbergii*)
White oak (*Quercus alba*)
Sour gum (*Nyssa sylvatica*)
Hazelnut (*Corylus americana*)
Butternut (*Juglans cinerea*)
Red mulberry (*Morus rubra*)
Shingle oak (*Quercus imbricaria*)
Redbud (*Cercis canadensis*)
Several species of hawthorn (*Crataegus*)
Linden (*Tilia glabra*)
Northern red oak (*Quercus borealis* var. *maxima*)
Honey locust (*Gleditsia triacanthos*)
Hackberry (*Celtis occidentalis*)
Bur oak (*Quercus macrocarpa*)
Winged elm (*Ulmus alata*)
Red-flowered buckeye (*Aesculus discolor* var. *mollis*)
Bladdernut (*Staphylea trifolia*)
Hop hornbeam (*Ostrya virginiana*)
Elderberry (*Sambucus canadensis*)
Black haw (*Viburnum rufidulum*)
Chittim-wood (*Bumelia lanuginosa*)
Moonseed (*Menispermum canadense*)
Fragrant sumac (*Rhus aromatica*)
Black cherry (*Prunus serotina*)
Ohio buckeye (*Aesculus glabra* var. *pallida*)

Red-flowered buckeye, found in rich, alluvial woods, is common only in the southeastern section of the state.

Some of the species mentioned above, namely, linden, white oak, chinquapin oak, northern red oak, black walnut, butternut, and sour gum, seem to have invaded the final stages of this associes by an incursion from the adjacent rich lower regions at the base of limestone bluffs or slopes where they were originally part of the

climax flora of these areas and having descended the ravines and slopes of the limestone areas gradually merged with the climax vegetation of the alluvial association (fig. 16). They may be considered a post-climax of the flood-plain association.

Sycamore is a very common species throughout the flood-plain development and persists into the very last associes. Together with elm and ash, sycamore and sugar maple are the dominant species in the final associes of the flood-plain flora. Birch likewise persists, but in a rich flood-plain is commonest adjacent to the river. Black

FIG. 16. Along Huzzah Creek, two miles southeast of Davisville, Crawford County.

willow and buttonbush do not persist into this final stage, but are represented here and there by isolated plants, usually near the water's edge.

Some of the herbaceous species common on the forest floor of the final flood-plain stage are:

Actinomeris alternifolia
Amphicarpa bracteata
Asarum canadense var. *acuminatum*
Blephilia hirsuta
Cystopteris fragilis var. *protrusa*
Dioscorea villosa
Eupatorium purpureum
Eupatorium urticaefolium
Galium triflorum
Geum canadense var. *camporum*
Impatiens pallida and *I. biflora*
Laportea canadensis
Lappula virginiana
Parthenocissus quinquefolia (young plants)
Passiflora lutea
Perilla frutescens
Phlox divaricata var. *Laphamii*
Phytolacca americana
Pilea pumila var. *Deamii*
Ranunculus abortivus
Sanguinaria canadensis
Sicyos angulatus
Toxicodendron radicans
Verbesina virginica
Viola eriocarpa
Viola striata

Sometimes the herbaceous flora of the rich wooded alluvium of the final stage will be found in the stage preceding. The two intergrade into their floral components, with a greater variety finally appearing in the final stage. The herbaceous ground flora associes of this final stage is very poorly represented, the spring flora being best developed.

II. SUGAR MAPLE–WHITE OAK ASSOCIATION

(*Acer saccharum–Quercus alba*)

The next association of the deciduous forest climax formation to be discussed is the sugar maple–white oak association. In its final developmental stages the flora of this association approaches closely

FIG. 17. Limestone glade along Niangua River, two miles south of Corkery, Dallas County.

the composition of the flood-plain association of sugar maple–bitternut hickory. The two arrive at nearly the same climax, namely, the mesophytic, deciduous forest, because the climatic climax is a mesophytic one, but the flood-plain association (sugar maple–bitternut hickory) begins as a hydrosere (its initial stage beginning in or near water), while the other (sugar maple–white oak) association begins as a xerosere (its initial stages beginning where there exists an extreme deficiency of water, as on bare limestone glades or exposed, rocky bluffs).

(1) The first stage takes place on bare, rocky, limestone glades or openings where the rock is exposed and the residual fragments are everywhere conspicuous. An herbaceous flora with largely a component of prairie species covers the glade (fig. 17). This first stage is

usually represented by the side-oats grama–perennial black-eyed Susan (*Bouteloua curtipendula–Rudbeckia missouriensis*) associes. In other portions of the Ozarks, as in some of the Ozark border counties, i.e. Benton County along the Osage River, *Silphium laciniatum* and *Psoralea tenuiflora* are dominant instead of *Rudbeckia missouriensis*, and occur with the co-dominant *Bouteloua curtipendula* (fig. 18). In other Ozark glades, as in the border counties of the Ozarks or in places where a rich prairie or grass flora covers open slopes, one finds *Andropogon provincialis* very common and co-dominant with *Bouteloua curtipendula*. Many other herbaceous plants are commonly found. The changing aspects of the glade are the result of the spring, summer, and autumn societies of plants. In the spring there are

FIG. 18. Limestone glade with dominants of *Silphium laciniatum*, *Psoralea tenuiflora*, and *Bouteloua curtipendula* on bluffs along Osage River, two miles northwest of Wisdom, Benton County.

societies of Missouri primrose (*Oenothera missourensis*), blue wild indigo (*Baptisia minor*), sandwort (*Arenaria patula*), wild hyacinth (*Camassia scillioides*), *Leavenworthia uniflora*, purple cone-flower (*Echinacea pallida*), yellow cone-flower (*Echinacea paradoxa*), *Galium virgatum*, and many others. In summer the conspicuous dominants are *Houstonia nigricans*, false aloe (*Agave virginica*), *Evolvulus Nuttallianus* (mostly in western Missouri), *Petalostemum purpureum*, *Centaurium texense* (in western Missouri), *Heliotropium tenellum*, *Tragia urticaefolia*, *Croton capitatus*, and calamint (*Satureja glabella* var. *angustifolia*). In the autumn the prevailing species are *Aster oblongifolius*, *A. sericeus*, wild onion (*Allium stellatum*), and perennial black-eyed Susan (*Rudbeckia missouriensis*). *Panicum*

virgatum, melic grass (*Melica nitens*), and big and little blue-stem (*Andropogon provincialis* and *A. scoparius*), together with side-oats grama (*Bouteloua curtipendula*), predominate among perennial grasses, while *Sporobolus vaginiflorus*, *S. neglectus*, and *Panicum capillare* predominate among annual grasses. *Sporobolus vaginiflorus* is a much more common and dominant grass over the balds of southwestern Missouri than it is on the eastern Ozark glades.

Herbaceous species found on the glades of the western Ozarks which are common in addition to the ones given below are *Palafoxia callosa*, *Linum sulcatum*, *Polytaenia Nuttallii*, and *Parthenium hispidum*. *Berchemia scandens* is often found. The *Tragia*, *Palafoxia*, *Berchemia*, and *Baptisia* are much more characteristic of and some are altogether confined to the western and southwestern Missouri glades and bald knobs.

FIG. 19. Red cedar glade or bald on dolomitic limestone, near Taney County line, in Stone County.

This first stage was the original condition which existed all over the Ozarks in limestone areas following uplifts. Then the gradually elevated, rocky terrain first became carpeted with an herbaceous flora such as is now found on eroded glades. As will be noted from what follows, the limestone glades have been and are gradually losing ground, i.e. are becoming covered by the forest (figs. 19, 20, 21, 24, and 25). In other words, *the natural succession, under the present mesophytic climatic climax, is towards a forest which sooner or later obliterates the glade.*

This pioneer herbaceous stage may last indefinitely. Those glades and eroded limestone slopes facing west or south remain

exposed longer than those facing east or north, because the dry sun and windswept conditions existing on such slopes are much more favorable for the development of an herbaceous flora than for a forest coverage (figs. 19, 20, and 21). The glade covering is too sparse and open to permit good windbreaks to hold leaves for decay, and those leaves which do remain are quickly scorched and dried in the sun so that leaf decay, rock disintegration, and soil formation proceed at a very slow rate. On east- and north-facing areas, more moisture and protection against prevailing winds exist, and soil building goes on at a relatively faster pace. Thus the succession taking place on north- and east-facing slopes culminates in the climax sugar maple–white oak associes at a relatively more rapid rate when compared with that taking place on a south- and west-facing area.

(2) The next stage to follow the pioneer herbaceous flora is usually initiated by the glade variety of fragrant sumac (*Rhus trilobata* var. *serotina*) and is soon joined by its associates, red cedar

FIG. 20. Bald knob west of Table Rock, west of Branson, Taney County.

(*Juniperus virginiana*) and persimmon. Any one of these may be dominant, but red cedar in most cases becomes the most conspicuous member and often forms a consociation by itself (fig. 19). "Cedar glades" are a common, characteristic feature of eroded limestone slopes and knobs (figs. 19 and 20). The ground cover is sparse under the red cedars and in a red cedar forest. Melic grass (*Melica nitens*), *Panicum virgatum*, and big and little blue-stem are grasses usually found in open areas in this associes. Some mosses, such as *Orthotrichum Porteri* and species of *Grimmia*, occur on the bare, exposed rocks.

Red cedar is dominant in the eastern Ozarks and in the country bordering the Piney and Gasconade River region, but on the bald knobs and bare limestone areas in the White River region of southwestern Missouri persimmon is often the pioneer and dominant species. On these balds, persimmon (fig. 21) or cedar is first, or the two occur simultaneously, and around shade in thickets at the same time occur *Rhus trilobata* var. *serotina*, *Symphoricarpos orbiculatus*, and *Smilax Bona-nox*. Sassafras sometimes grows as a pioneer with persimmon, especially if there is more chert in the rock. Then follows *Bumelia lanuginosa* (fig. 22) succeeded by the *Cotinus americanus*–

FIG. 21. *Diospyros virginiana* initiating woody growth on limestone glade along Niangua River, two miles south of Corkery, Dallas County.

Quercus Muhlenbergii stage, which is associated with *Quercus Shumardii* var. *Schneckii*, *Rhus trilobata* var. *serotina*, *Cercis canadensis*, and *Chionanthus virginica* (example No. 49). On some of the dolomitic limestone glades and knobs here, persimmon and *Rhus trilobata* var. *serotina* appear to be the pioneers, with cedar absent or suppressed. If this happens, *Cotinus* and *Quercus Muhlenbergii* follow the cedar–*Rhus trilobata* var. *serotina* stage, without the occurrence of cedar. With persimmon are also *Ulmus alata* and *Bumelia lanuginosa*, and sometimes *Viburnum rufidulum*, but *Rhamnus caroliniana* and *Chionanthus virginica* are later in the succession than *Quercus Muhlenbergii* or *Cotinus*, or infrequently come at the same time. *Aster oblongifolius* is common on the glades, while *Aster sericeus* is rare. In some places persimmon and cedar alone occur, while in others persimmon, cedar, and winged elm dominate. Sassafras is often dominant with persimmon on some of the bald knobs. Along draws in the limestone

glade the most common pioneering plants are *Physocarpus, Andrachne, Ilex decidua, Rhamnus caroliniana, Cornus obliqua,* and *C. asperifolia.* These draws may occur in slight depressions or valleys between the balds or may occur on a slope. *Chionanthus* appears around draws and drainage crevices and occurs as a substory with *Cotinus, Cornus florida, Acer saccharum, Ilex decidua, Cornus asperifolia, Quercus Shumardii* var. *Schneckii, Rhamnus caroliniana,* and *Physocarpus.*

The normal glade, thus far discussed, in most of the Ozarks, including the last two stages discussed, is still open, but gradually becomes forested (figs. 23, 24, and 25); with the incursion and development of red cedar and persimmon, the rocks become covered by leaves. This next stage of development results when the trees gain a foothold and thereby serve as windbreaks with consequent leaf preservation on the ground. With the gradual rock disintegration

FIG. 22. *Quercus Muhlenbergii* invading an associes with *Diospyros virginiana* and *Bumelia lanuginosa* along the bluffs of Osage River (Lake-of-the-Ozarks), at Riverview, Morgan County.

and increase of soil, an incursion of various shrubs appears, and the third stage of the succession follows.

(3) This is the chittim-wood–black haw (*Bumelia lanuginosa–Viburnum rufidulum*) associes. While these two species are dominant, others also may be abundant and these are usually greenbrier (*Smilax Bona-nox*), supplejack (*Berchemia scandens*), and species of hawthorn (*Crataegus*) or hackberry (*Celtis pumila* var. *georgiana* or *C. laevigata* var. *texana*).

Once this stage has been reached, other shrubs and trees rapidly begin to take possession, and red cedar, once so conspicuous on the glade, gradually loses ground.

(4) An associes that usually follows is that of the winged elm–Indian cherry (*Ulmus alata–Rhamnus caroliniana*). Associated with these species usually is the southern hackberry (*Celtis laevigata* var. *texana*), stunted specimens of white ash (*Fraxinus americana*), and possum haw (*Ilex decidua*).

(5) This is quickly followed by the next associes, chinquapin oak–white ash (*Quercus Muhlenbergii–Fraxinus americana*), which

FIG. 23. *Quercus Muhlenbergii–Fraxinus americana* associes dominating grassy slopes along headwaters of Bryant Creek, two miles southeast of Cedar Gap, Wright County. Shows incursion of forest over prairie-glade slopes with gradual elimination of the latter.

dominates west- and south-facing slopes. In the eastern and southeastern Ozarks the chinquapin oak–white ash stage appears as one associes, but on the White River bald knobs this stage is equivalent to the chinquapin oak–*Cotinus* associes discussed previously. The chinquapin oak–white ash associes has a rich variety of other trees and shrubs, among which may be found hop hornbeam (*Ostrya virginiana*), redbud, slippery elm (*Ulmus fulva*), *Quercus Shumardii* var. *Schneckii* (a variety of red oak sometimes confused with Texas red oak), and blue ash (*Fraxinus quadrangulata*). Greenbrier, as well as species from the preceding associes, such as black haw (*Viburnum rufidulum*), winged elm (*Ulmus alata*), and hop hornbeam usually occur in this associes (fig. 28). Sometimes blue ash is much more conspicuous in portions of the Ozarks along limestone bluffs

and becomes a dominant species, forming an associes with *Bumelia lanuginosa*, immediately following an occupation by *Viburnum rufidulum*, *Rhamnus caroliniana*, and *Rhus trilobata* var. *serotina*, or else occurring simultaneously with them. On west- and south-facing slopes and bluffs this associes may last indefinitely and form more or less of a climax or subclimax stage, the arrested development characterizing such a subclimax being due to exposed conditions which favor the persistence of such a flora. Chinquapin oak is particularly abundant in such exposures. On the more rocky slopes in this associes, a temporary substory of winged elm, hop hornbeam, black haw, and *Bumelia lanuginosa* may appear dominant but is finally superseded in the following climax forest associes, where these species become inconspicuous. On rocky slopes in this and the following stage with sugar maple, *Brickellia grandiflora* may frequently be dominant. At this stage the herbaceous flora is dominated on the rocky lime-

FIG. 24. Bald knob, just east of McClurg, Ozark County. Showing the *Acer saccharum–Quercus alba* climax reached in the development of a limestone substratum, and the covering of the glade by forests of this climax stage.

stone slope by *Pilea pumila* var. *Deamii*, *Impatiens pallida* and *I. biflora*, *Hydrophyllum appendiculatum*, *Campanula americana*, and *Polymnia canadensis*. This may, however, be a derived condition brought on by burning. At this stage a sedge (*Carex eburnea*) usually occurs in the bluff crevices where a slight accumulation of soil exists, and grows with mosses such as *Rhodobryum roseum* and *Thuidium minutulum*. A great variety of grasses is present at this stage among the ledges and rock exposures where soil has accumulated. They include species of *Muhlenbergia*, *Brachyelytrum erectum*, *Uniola*

latifolia, wild rye (*Elymus virginicus*), chess (*Bromus purgans*), fescue (*Festuca obtusa*), bottlebrush (*Hystrix patula*), and *Sphenopholis intermedia*.

On the edges of bluffs (fig. 22) in associes Nos. 2, 3, 4, or 5 of *Quercus Muhlenbergii–Fraxinus americana* or *Bumelia–Diospyros* is an herbaceous flora characterized by:

Allium mutabile
Asclepias stenophylla
Euphorbia (zygophylloides) missurica
Heleotropium tenellum
Helianthus Maximiliani
Houstonia nigricans
Isanthus brachiatus
Liatris cylindracea
Malvastrum angustum
Mentzelia oligosperma
Mirabilis albidus
Psoralea tenuiflora
Scutellaria parvula
Solidago Drummondii
Solidago radula

FIG. 25. Three miles northwest of Vichy, Maries County. Similar to Fig. 24, except that forest of *Acer saccharum–Quercus alba* associes has more nearly closed the originally open glade. Cf. Figs. 24 and 25 with Figs. 19, 20, and 21.

These open bluff slopes may vary in their herbaceous composition according to the amount of chert or limestone present, the amount of lime which has been eroded, and other factors. If there is much more chert than lime present, acidity prevails and *Polygonum tenue*, *Acalypha gracilens* var. *monococca*, *Linum medium* var. *texanum*, *Psoralea psoralioides* var. *eglandulosa*, *Stylosanthes biflora* var. *hispidissima*, *Lechea tenuifolia*, *Crotonopsis elliptica*, *Scleria pauciflora*, and *Crotalaria sagittalis* predominate; while, if limestone predominates, limestone-loving species occur, such as *Malvastrum angustum*, *Isanthus brachiatus*, *Heliotropium tenellum*, *Houstonia nigricans*, *Linum sulcatum*, *Helianthus Maximiliani*, *Allium mutabile*, *Euphorbia (zygophylloides) missurica* (in the western Ozarks), *Verbena simplex*, *Asclepias stenophylla*, and *Mentzelia oligosperma*.

Species commonly occurring along the edges of the bluffs are *Solidago radula, S. Drummondii, Liatris squarrosa, L. cylindracea,* and sometimes on very high, exposed situations of west- or south-facing bluffs are *Arenaria stricta* var. *texana* and *Muhlenbergia cuspidata* (fig. 16).

Some of this flora is, of course, persistent from the original type which occurred on the limestone glade in the beginning while yet a part of the original cover. This is true of the types not on the very edge of the bluff. The very edge of the bluff has distinctive groups of species, such as *Solidago Drummondii, S. radula,* and *Liatris cylindracea,* which are usually not on the open or more level parts of the glade proper.

(6) At the beginning of this last associes, sugar maple makes its appearance. Not until sufficient soil has accumulated on the limestone exposures does it usually penetrate the area, although very

FIG. 26. *Acer saccharum–Quercus alba* climax associes, well developed over a limestone substratum, Taney County.

little soil is needed to induce it to appear frequently. It is much more abundant on north- and east-facing slopes at the same stage when chinquapin oak is dominant on south- and west-facing ones. Often on these south- and west-facing slopes it may be almost as common as chinquapin oak. As more soil is formed over the limestone substratum which originally was an open glade (figs. 24 and 25), sugar maple becomes commoner, and finally attains a dominance, forming, with white oak, the last stage of development, the sugar maple–white oak associes. On north- and east-facing slopes sugar

maple becomes the dominant species. The common species of trees in this climax associes are white oak (*Quercus alba*), northern red oak (*Quercus borealis* var. *maxima*), linden (*Tilia glabra*), and butternut (*Juglans cinerea*). These north-facing limestone slopes produce the climax mesophytic forest with white oak, northern red oak, and sugar maple dominating. Usually on such north-facing slopes the lower portions are covered by linden, northern red oak, and white oak, while on the upper slopes northern red oak and sugar maple are usually dominant (fig. 26).

The dominant understory in this climax associes of sugar maple–white oak consists of flowering dogwood and American hornbeam or

FIG. 27. Bluffs along White River just west of Shreiner's Ferry, Barry County, showing at left all stages of succession from a gravel bar in the initial development of a flood-plain association to the final stage (*Acer saccharum–Quercus alba*) of the development over an eroded limestone bluff or open glade.

ironwood (*Carpinus caroliniana*), while a lower story may be composed of spicebush (*Benzoin aestivale*) and bladdernut (*Staphylea trifolia*). As the soil becomes richer, deeper, and consequently of greater water-holding capacity, these shrubs in the climax associes succeed in becoming dominant over those of the preceding associes, i.e. hop hornbeam, winged elm, black haw (*Viburnum rufidulum*), and *Bumelia lanuginosa*, the understory once dominant on drier exposures. In some portions of the southeastern Ozarks the running strawberry-bush (*Euonymus obovatus*) and the eastern witch hazel (*Hamamelis virginiana*) (examples Nos. 78, 79, 80, and 101) may be locally dominant in the understory flora of north- and east-facing limestone slopes.

Variations in Stage No. 6:

(*a*) In some portions of the Ozarks, *Cornus florida* and *Staphylea* are dominant as a substory, while in other parts they are not. In certain parts of the western Ozarks, as in the Swan Creek territory of Christian County, *Viburnum molle* is a local co-dominant in a sugar maple–chinquapin oak–northern red oak woods as a substory

FIG. 28. Bee Bluff, along Current River, northeast of Eminence, Shannon County, showing the development of vegetation over a limestone bluff.

co-dominant with pawpaw, *Carpinus*, *Benzoin*, and *Staphylea* (example No. 70), while black maple (*Acer nigrum*) often becomes a local dominant (example No. 71) instead of sugar maple on rich, north-facing slopes along Bull Creek, Christian County, along Swan Creek in Christian and Taney counties (examples Nos. 69 and 70), Montauk Spring Branch, in Dent County, some portions of the Gasconade River in Pulaski County (example No. 89), and Bryant Creek in Wright and Douglas counties. In this case the climax is

made up of black and sugar maple, linden (*Tilia glabra*), and northern red oak.

(*b*) Similarly, *Cornus alternifolia* becomes a local substory codominant with *Staphylea* on north-facing slopes in certain parts of the eastern Ozarks, as at Montauk State Park, Dent County (example No. 94), Bee Fork of Black River, Reynolds County, certain parts of the Gasconade River in Pulaski County, certain places along the North Fork of White River in Douglas County, Bryant Creek in Wright County, along portions of Jacks Fork of Current River and tributaries in Shannon and Texas counties, and along Noblett and Spring creeks in parts of northwestern Howell County.

(*c*) Sugar maple is often dominant with chinquapin oak on west- and south-facing areas rather than with red oak in the White River region of southwestern Missouri. *Morus rubra, Quercus Muhlenbergii,* and *Celtis occidentalis* are dominant on south- and west-facing areas. On areas in the chinquapin oak–sugar maple association in the White River region, *Cladrastis lutea* is associated with *Ulmus americana, Cercis, Celtis occidentalis, Morus rubra,* pawpaw, benzoin, *Symphoricarpos, Viburnum rufidulum,* and *Juglans nigra* (example No. 66). In this association *Yucca arkansana* occurs in association with *Smilax Bona-nox, Elymus virginicus,* and *Berchemia.* In the White River area *Robinia Pseudo-Acacia* is native and part of the substory with pawpaw, benzoin, and redbud in the sugar maple–northern red oak–chinquapin oak area, and occurs at the base of bluffs on rich slopes. This *Robinia* with its associates may be placed also in the final stage of the alluvial associations.

(*d*) White oak is not part of the dominant last associes in this final association in the White River area. The east-facing slopes are dominated by sugar maple, northern red oak, linden, *Juglans cinerea* (all found in the eastern Ozarks), as well as *Celtis occidentalis,* with the lower story or substory dominated by *Staphylea,* pawpaw, and *Carpinus,* as in the eastern Ozarks. Dogwood, which is a dominant in substory in the eastern Ozarks, practically does not occur here.

(*e*) All these local dominants are found only in certain areas, and their distribution is limited. They do not enter the picture in all the plant successions within the Ozarks. For example, along Pomme de Terre River in Hickory County, *Carpinus* becomes less abundant and *Staphylea* and pawpaw predominate.

(*f*) On north- and east-facing limestone slopes where the climax type is reached, the herbaceous flora may be dominated by liverleaf

(*Hepatica acutiloba*), early meadow rue (*Thalictrum dioicum*), and thin grass (*Agrostis perennans*). Various mosses, such as *Mnium cuspidatum* and other species of *Mnium*, *Platygyrium repens* and *Orthotrichum pusillum*, may be common in this associes.

(*g*) The herbaceous flora may have also *Bromus purgans*, *Festuca obtusa*, *Hystrix patula*, *Osmorhiza Claytoni*, *Athyrium pycnocarpon*,

FIG. 29. Bee Bluff, along Current River, northeast of Eminence, Shannon County, in the southeastern Ozarks; showing the development of vegetation on a limestone bluff.

Sanicula canadensis, *Actaea pachypoda*, *Eupatorium urticaefolium*, and *Veratum Woodii*. *Thalictrum dioicum* is locally dominant on rich, north-facing slopes along Swan Creek, Christian County, Bee Fork, Reynolds County, some parts of the Gasconade River in Pulaski County, some parts of White and James rivers in Stone, Taney, and Barry counties, some parts of the Osage River in St. Clair County, and elsewhere in the Ozarks.

The climax development of a limestone slope will, therefore, be seen to simulate mostly the climax associes of a flood-plain development, the most common element in both being sugar maple. In both associations ironwood (*Carpinus caroliniana*) and flowering dogwood are conspicuous members of the understory. The one association begins as a hydrosere while the other starts as a xerosere, yet each ends in the climatic mesophytic climax. Since sugar maple favors alkaline to neutral soils, it naturally is found in both associations, in the flood-plain the development appearing on the richest

FIG. 30. Limestone bluffs along Eleven Points River, near mouth of White Creek, Oregon County, showing somewhat more advanced stage of cover than in Figs. 28 and 29.

alluvial climax soils, while on the limestone slope development it responds to the calcareous soils.

Likewise there is much interchange and overlapping of floras of the two preceding climax associations, particularly where the flora of the rich lower portions of the limestone slopes merges into that of the flood-plain flora. This is conspicuous in the case of such plants as pawpaw, bitternut hickory (*Carya cordiformis*), leatherwood, butternut, spicebush (*Benzoin aestivale*), buck brush (*Symphoricarpos orbiculatus*), and linden (*Tilia glabra*). These species occupy the lower slopes of the limestone flora, and occur also in the climax associes of the flood plain.

It should be borne in mind that one limestone hillside may show all stages of the succession. Very often most of the hillside will have reached a stage where most of the slope is covered with fairly deep soil and is well forested except for a few exposed rock outcrops

(fig. 27). The species of the deeper soil adjacent to the rock outcrops are constantly pioneering on any new portions of the outcrop or glade where some soil is available so that they can gain a foothold. This means that they are gradually crowding in on these rocky habitats marginal to the open glade or rock formation.

In the case of a limestone bluff, the succession starts similarly to that of the limestone glade from a xerosere stage and eventually reaches the climax associes of sugar maple–white oak. However, the succession in the former case is much more rapid, and differs somewhat from that of the limestone glade on account of the difference in gradient of the slope, which affects the drainage and moisture relationships markedly. In the beginning stages of a limestone bluff formation only a few herbs take hold in the crevices of the bluff. Common pioneer types are hydrangea (*Hydrangea arborescens*), columbine (*Aquilegia canadensis*), poison ivy (*Toxicodendron radicans*), bulblet bladder fern (*Cystopteris bulbifera*), cliffbrake fern (*Pellaea glabella* and *P. atropurpurea*), Virginia creeper (*Parthenocissus quinquefolia*), and alum root (*Heuchera puberula* and *H. americana* var. *hirsuticaulis*).

As more soil accumulates and rocks disintegrate, a few hardy trees and shrubs, such as red cedar, *Bumelia lanuginosa*, *Rhus trilobata* var. *serotina*, *Physocarpus opulifolius* var. *intermedius*, and others, gain a foothold and help break up the rock and aid in soil formation (figs. 28, 29, and 30). More rapid succession takes place as a talus slope is built up with consequent occupation by many species, such as leafcup (*Polymnia canadensis*) and bladdernut (*Staphylea*), which carry the succession rapidly forward eventually toward the climax associes.

Thus far the associations which have been discussed are those whose final stages at least have developed largely from neutral to calcareous soils. We come now to a discussion of associations whose development proceeds from an acid type of soil.

III. OAK–HICKORY ASSOCIATION

(Quercus–Carya)

The first of these associations to be described is the oak–hickory. This is the common and prevailing association over most of the Ozark ridges, uplands, and upper slopes of hills. It develops on the drier and more acid of the ridge tops and upper slopes (fig. 31) and is probably the most complex association found in the Ozark region.

Just as a sugar maple–white oak association originates from an open limestone glade, so the oak–hickory association takes its origin from a prairie association beginning on an acid substratum. Many parts of the plateau now covered with a dense stand of oak–hickory were, according to the early settlers and records of travelers and writers, originally a prairie. This again illustrates the natural tendency under a climatic mesophytic climax for an open barren or prairie habitat to end in a forested area. The upland prairie flora of much of the Ozarks overlies areas of acid soils produced by Roubidoux sandstone or residual chert. The prairie flora which covers an

FIG. 31. A typical Ozark landscape, showing the abundant coverage by the oak–hickory association on the ridge tops and plateaus. South of Harley, Barry County.

upland may also originate on a sandstone, chert, granitic, or porphyritic trachyte barren (fig. 32), of which there are many types scattered throughout the Ozarks.

(1) The first woody plants to invade this prairie flora are sassafras and winged sumac (fig. 33). Each forms local colonies and together they comprise the first developmental stage of the association, the sassafras–winged sumac (*Sassafras albidum* var. *molle–Rhus Copallina*) associes. Fragrant sumac (*Rhus aromatica*) also at times forms societies in this associes. Persimmon alone frequently initiates instead of sassafras and winged sumac. Grasses and sedges common at this stage are wild oats grass (*Danthonia spicata*), slender fescue (*Festuca octoflora*), *Cyperus filiculmis*, and *Panicum linearifolium*.

(2) With the next stage the development of the forest flora becomes conspicuous, for it is at this time that black jack oak and

post oak penetrate the area. Usually these two trees are already present in a forest area contiguous to the prairie and merely move into the open territory afforded them. Black jack oak usually penetrates the area first, followed by post oak, the two constituting the black jack–post oak (*Quercus marilandica–Quercus stellata*) associes. This associes may form a temporary climax or subclimax over certain areas, and is particularly well developed on broad, level expanses of plateau of the Ozark Dome, as is especially well displayed on the level uplands in parts of Dent, Crawford, Shannon, Texas, Phelps, and Howell counties. Incursion of these oaks into

FIG. 32. Porphyritic trachyte glade of Red Rock Mountain, near Irondale, Washington County, showing a type of habitat which may be invaded by a prairie flora eventually culminating in an oak–hickory climax.

prairie habitats may frequently be observed along level prairie areas such as railroad right-of-ways and natural grassy openings bordering woods (fig. 34). This pioneering tendency of these scrub oaks to penetrate the prairie habitats is shown by the black jack–post oak "flats," which, according to earlier records and reports made by travelers and settlers in the region, were originally level, open, treeless expanses. In this associes the grasses of the preceding associes continue to occur, while broom sedge (*Andropogon virginicus*) and several species of *Panicum* also are found.

(3) The next successional development occurs with the entrance of black oak (*Quercus velutina*) into the black jack–post oak associes. Along with black oak usually appears Ozark hickory[1] (*Carya Buckleyi*

[1] The name Ozark hickory is applied here to distinguish this characteristic small-fruited Ozark species from *Carya glabra* and *C. cordiformis*, both known as pignuts. Since it would be very misleading to speak of a third type of hickory in Missouri as "pignut," the name "Ozark hickory" is preferred.

var. *arkansana*) and the two form a black oak–Ozark hickory associes (fig. 35). Since black jack and post oaks are light-demanding types, they begin to lose ground with the incursion into their associes of black oak. Black oak grows so much faster and eventually taller than the black jack and post oak that in time the latter become shaded, and this marks the beginning of an end for them; in other words, the beginning of another stage of the succession.

This black jack–post oak associes is the first of a later oak–hickory climax to invade the bald knobs and limestone glades of

FIG. 33. *Rhus Copallina* invading prairie habitat, one mile from Riverview bluffs, Morgan County. This is the first woody stage in the development of the oak–hickory association.

southwestern Missouri. Post oak and black jack oak begin this succession associated with the Ozark hickory; then black oak and Ozark hickory enter. On the knobs in later stages of succession are white oak and black oak, with post oak and Ozark hickory. The herbaceous flora found in this stage consists principally of *Tephrosia virginiana, Schrankia Nuttallii, Antennaria plantaginifolia, Lespedeza procumbens, Aster patens, Ascyrum hypericoides* var. *multicaule, Desmodium rotundifolium, Panicum dichotomum, P. sphaerocarpon, P. lanuginosum* var. *fasciculatum, P. flexile,* and *Acacia angustissima* var. *hirta.*

Usually black oak is the first to enter the black jack–post oak associes, but the oak–hickory association is a most complex one, and several other dominants or consociations may enter the black jack–post oak associes.

(*a*) There may be, for example, an incursion of white oak, which becomes dominant and with the black oak forms a white oak–black

oak associes. Or scarlet oak in the eastern Ozarks, as far west as Indian Creek and tributaries in Douglas County, may be the dominant oak type to penetrate the black jack–post oak associes.

(*b*) There may be an associes of scarlet oak–black oak with the scarlet oak predominant, or an associes of scarlet oak–Ozark hickory in which black oak is present, or there may be various mixtures of dominants, such as scarlet oak–Ozark hickory with black oak–Ozark hickory, or scarlet oak–black oak and white oak mixed.

(*c*) Sometimes in some of the porphyritic or granitic or sandstone territory in the southeastern Ozarks, in parts of St. Francois, Madison, Iron, Reynolds, and Wayne counties, winged elm, succeeding the black jack–post oak stage, may dominate to form an associes of winged elm–Ozark hickory (*Ulmus alata–Carya Buckleyi* var. *arkansana*).

FIG. 34. Upland woods with dense, grassy cover near head of Mud Creek, twelve miles north of Poplar Bluff, Butler County. Illustrates encroachment of oaks into prairie habitat, and shows the dominance of the blue-stem grasses in protected and unburned areas of pine or pine–oak forests. The area illustrated was unburned for many years.

(*d*) Also, in some parts of the Ozarks, as for example in the Potosi Ranger District of the Clark National Forest Purchase Unit in Washington County, northern red oak may follow a black jack–post oak associes and become dominant, together with black oak forming a northern red oak–black oak associes.

(*e*) In parts of southern Missouri southern red oak (*Quercus falcata*) may become dominant where it occurs, and with scarlet and black oak form an associes following a black jack–post oak associes.

The dominant understory shrubs of these various mixed oak–hickory associes consist of low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*) (fig. 35), and high-bush huckleberry (*Vaccinium stamineum* and its var. *neglectum*). Low-bush huckleberry continues to dominate and exist throughout the Ozark region, but the high-bush

FIG. 35. An oak–hickory associes on a flat upland near Dillard, Crawford County. *Vaccinium vacillans* var. *crinitum* is the dominant understory in such associations.

huckleberry begins to disappear as the northern and western borders of the Missouri Ozarks are reached. Under a scarlet oak–black oak associes or scarlet oak–Ozark hickory associes deerberry or farkleberry (*Vaccinium arboreum* var. *glaucescens*) is dominant. It may be common also in other associes. While *Vaccinium vacillans* var. *crinitum* is usually the climax understory in an oak–hickory or pine–oak associes, it may not always be. Sometimes, as in northeastern Wright County near Beaver Creek, there is instead of *Vaccinium vacillans* var. *crinitum* a great variety of herbs of an acid

soil flora, such as species of *Desmodium* and *Lespedeza, Psoralea psoralioides* var. *eglandulosa, Aureolaria grandiflora* var. *cinerea, Hieracium Gronovii,* species of *Panicum, Galactia volubilis* var. *mississippiensis, Solidago radula,* and others. Other common dominants forming the ground cover are summer grape (*Vitis aestivalis*), New Jersey tea (*Ceanothus americanus*), and *Lespedeza procumbens.* Fragrant sumac (*Rhus aromatica*) and sassafras are commonly found in the oak–hickory association from the black jack–post oak stage on. Winged sumac (*Rhus Copallina*) also is common in the association.

Sometimes black jack oak is absent from an area, leaving black oak, white oak, post oak, Ozark hickory, and shagbark hickory as associates. Ozark hickory is commoner usually on ridges or plateau tops and on south- and west-facing slopes than it is on north- or east-facing ones.

On the so-called "post oak flats," post oak, white oak, and Ozark hickory may be the common species, with white oak dominating. In some associes scarlet oak may be the abundant tree while in others it may be black oak.

These associes of the upland and ridge tops in the Ozark all develop on acid substrata and the herbaceous ground cover is tolerant of acid soil. In order of abundance throughout all the associes, in addition to those already listed, they are: dittany (*Cunila origanoides*), oats grass (*Danthonia spicata*), pussy toes (*Antennaria plantaginifolia*), goat's rue (*Tephrosia virginiana*), *Lespedeza repens, Panicum lanuginosum* var. *fasciculatum, Lespedeza hirta, Panicum dichotomum, Carex hirsutella,* cinquefoil (*Potentilla simplex* var. *genuina*), tick trefoil (*Desmodium marilandicum* and *D. rotundifolium*), and *Carex artitecta.* Other common herbaceous plants are *Aster patens, A. turbinellus, A. anomalus, A. linariifolius, Solidago ulmifolia,* and *S. petiolaris* var. *Wardii.*

Leucobryum, Catharinea, Polytrichum, and *Dicranum* are usually the most abundant mosses in this oak–hickory association; while of grasses, oats grass (*Danthonia spicata*), species of *Panicum,* and occasionally blue-stem (*Andropogon scoparius* and *A. provincialis*) are most conspicuous.

IV. OAK–PINE ASSOCIATION

(Quercus–Pinus echinata)

The next association, the oak–pine, will require some prefacing. Weaver and Clements (*Plant ecology*) consider pine only as a fire subclimax of the deciduous forest. This will be more fully discussed later. Suffice it to state at this time that these studies reveal that

southern yellow pine (*Pinus echinata*) in the Ozark region has not developed as a fire subclimax, but has originated as a natural association which is usually mixed with various climax species of oak. This association consists of two associes: (1) a pure pine type with species of *Vaccinium* forming the understory, which may be called the pine–

FIG. 36. *Pinus echinata* developed in almost pure stand on Pine Bluff, overlying Roubidoux sandstone along Meramec River, four miles south of St. Clair, Franklin County.

huckleberry (*Pinus echinata–Vaccinium*) associes, and (2) the mixed oak–pine (*Quercus–Pinus*) associes.

Pine occurs on acid soils associated with such rocks as sandstone, chert or flint, and granite or porphyritic trachyte, which yield acid soils. On such soils it is usually found on the upper slopes of hills, or on narrow ridges underlain by sandstone or chert. It is much commoner on the narrower ridges than on the broader, flat, undissected plateau portions; in other words, it is most dominant where the upland is most dissected and the drainage pattern best developed.

(1) Pure stands of pine are rare today and occur locally along the tops and upper slopes of the ridges and on bare sandstone or chert glades or outcrops (figs. 36 and 37). A pure pine associes may start wherever exposed acid rock or the like occurs. On such bare or exposed areas pine, free from any other woody species, pioneers by

FIG. 37. Pure pine stand on ridge top north of Bunker, Reynolds County. Note the sparse herbaceous undergrowth characteristic of the coverage under a pure pine grove.

seeding itself. This incursion by pine on open ledges and outcrops free from competitors results in a local pure stand. Species of blueberry, locally called huckleberry, low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*), *Vaccinium stamineum* and its var. *neglectum*, and farkleberry (*Vaccinium arboreum* var. *glaucescens*) comprise the climax understory in the pure pine associes. The herbaceous ground cover under pure pine is very sparse, consisting mostly of *Lespedeza procumbens* and *L. repens*, horsemint (*Monarda Bradburiana*), catgut (*Tephrosia virginiana*), dittany (*Cunila origanoides*), tick trefoil

(*Desmodium marilandicum* and *D. rotundifolium*), and pussy toes (*Antennaria plantaginifolia*). Species of *Panicum* (*P. linearifolium*, *P. dichotomum*, *P. commutatum* var. *Ashei*, and *P. lanuginosum* var. *fasciculatum*), slender fescue grass (*Festuca octoflora* var. *tenella*), oats grass (*Danthonia spicata*), species of *Carex* (*C. hirsutella* and *C. artitecta*), broom sedge (*Andropogon virginicus*), and blue-stem (*Andropogon scoparius* and *A. provincialis*), comprise the dominant grasses and sedges. Such pure stands of pine today occur around Pickle Creek and River Aux-Vases in Sainte Genevieve County, and in portions of the Piney and St. Francis River country. Extensive lumbering has diminished much of the pine stands, and pine forests were formerly much more numerous in many places than they are today.

(2) Much more common than the pure pine associes is the mixed oak–pine associes, which may have several variations. The associes may consist of (*a*) black jack and post oak with pine, or (*b*) black oak, mockernut hickory, and Ozark hickory with pine, or of (*c*) white, black, and scarlet oak, Ozark hickory and shagbark or mockernut hickory with pine. The last type is the commonest and climax stage, in which pine is associated with the dominant or climax species of the oak–hickory association. This last stage develops from the second, which in turn proceeds from the first stage of succession with the pine.

Variations in Stage No. 2:

(*a*) The first type, with black jack, post oak, and pine usually develops in an area where a pine stand is contiguous to a black jack–post oak woods. At the zone of contact between the two some of the black jack and post oak seed themselves in natural openings in the pine forest, and in time form a mixed forest with the pine. In other words, the oak has penetrated into the pine forest rather than vice versa. The black jack and post oak also may enter a pine stand when the latter is developed on bare sandstone or chert outcrops. Such exposures of acid rock or even shallow soil areas with acid rock near the surface may give a foothold here and there for pioneer black jack and post oak. Once these oaks take hold, they begin to increase in other openings and again the mixed type occurs.

(*b*) Pine grows faster and consequently taller than black jack and post oak and is never actually dominated or towered over by them. In time, however, black oak, together with the hickories mentioned in the second type, invades the black jack–post oak–pine associes, and enters into competition with the pine, finally suppress-

ing, by over-shading, the black jack and post oak. The oaks or hickories, while they do not succeed in overtopping the previously existing growth of pine with its more rapid rate of growth, may eliminate it by over-shading and crowding out the seedling pines.

(c) The third and climax stage of mixed oak and pine occurs after white and scarlet oak penetrate the last associes. This climax type is best developed on the narrow ridges and upper slopes of hills or heads of ravines and draws (fig. 15). A similar understory of species of *Vaccinium* dominates this associes; likewise, the herbaceous ground flora and grass associes is the same, with the exception that it is usually more luxuriant and of greater density than in a pure pine associes. The commonest mosses in this associes are *Leucobryum albidum, Catharinea, Dicranum scoparium, Polytrichum ohiense, Ciriphyllum Boscii,* and *Aulacomnium heterostichum.* Other shrubs besides *Vaccinium* in this associes are greenbrier (*Smilax glauca* var. *leurophylla*), smooth sumac (*Rhus glabra*), and winged sumac (*Rhus Copallina*). There is usually an abundance of broom sedge (*Andropogon virginicus*) and little blue-stem (*Andropogon scoparius*) in this stage.

The existence of pure pine stands of greater extent than those today will be discussed in a later portion of this paper.

V. WHITE OAK–RED MAPLE ASSOCIATION

(*Quercus alba–Acer rubrum*)

The last association to be discussed is that of white oak–red maple (*Quercus alba–Acer rubrum*). This would probably be united by Weaver and Clements with the oak–hickory association, but it always takes its origin from the same type of topographical expression and is so distinct that it seems a most natural one. This association commonly develops from drainages in acid soil areas, such as slight draws in ravines, heads of tributaries of streams, and upper slopes of hills and ravines. It may be initiated in the following manner: From the run-off following rains along the angle of dip of a slope, an otherwise level, broad plateau may develop a slight draw (or wash), which eventually serves as a path (or course) along and down which rainwater will trickle.

(1) This draw is occupied by the first stage, the flowering dogwood–sour gum (*Cornus florida–Nyssa sylvatica*) associes. These two trees pioneer with sassafras.

Sometimes on gravel washes which begin high or far up the ravines at the headwaters of a tributary, Ozark witch hazel (*Hama-*

melis vernalis) may be found, and in such places Ward's willow may also be present. The Ozark witch hazel occurs on draws which lead eventually into a stream or tributary of a stream, but is not found where an upland slope does not lead directly into a tributary.

On the gravel wash or cherty draw of the first stage of succession shrubby St. John's-wort (*Hypericum prolificum*) and hazel (*Corylus americana*) are often found.

(2) As the drainage head becomes more deeply dissected and a larger and deeper ravine develops, other species enter, and by this time red maple, which had previously made its appearance in the first associes, now becomes the dominant member, with mockernut hickory, to form the second stage of development, the red maple–mockernut hickory (*Acer rubrum–Carya tomentosa*) associes. In this associes smooth sumac (*Rhus glabra*), winged elm (*Ulmus alata*), and serviceberry (*Amelanchier canadensis*) are found together with the other woody species of the preceding associes. Pine may enter at this stage where footholds on open, rocky places occur. The pine in such places is scattered because of the discontinuous nature of the openings and the consequent more or less crowded conditions for entering the associes. As one approaches the northwestern limit of the Ozark region, red maple and sour gum, here at their northwestern distributional limits within Missouri, gradually become less conspicuous and drop out of the associes as important species, their places being taken more conspicuously by serviceberry, Ozark hickory, and flowering dogwood.

As the ravine is deepened and more soil accumulates, the forest becomes well mixed with other species and a number of oaks of sour soil types enter, such as white, scarlet, and black oaks. Northern red oak may occur; in this associes bitternut hickory often appears.

(3) Although the white oak had made its appearance at an earlier stage of succession, it now becomes the dominant species with red maple and forms the final stage, the white oak–red maple (*Quercus alba–Acer rubrum*) associes. Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*), farkleberry (*Vaccinium arboreum* var. *glaucescens*), and fragrant sumac (*Rhus aromatica*) comprise the main understory shrub layer, and in the southeastern Ozarks greenbrier (*Smilax glauca* var. *leurophylla*) should be included as a common member of the understory. The herbaceous ground cover consists of the usual thin, rocky, acid soil dominants of catgut, dittany, and some others, such as bracken fern (*Pteridium latiusculum*), *Lespedeza hirta*, and tick trefoil (*Desmodium marilandicum*

and *D. rotundifolium*), *Aureolaria grandiflora* var. *cinerea*, *A. pectinata*, *A. calycosa* (in the southeastern Ozarks), *Aster linariifolius*, *Solidago hispida*, and *Houstonia longifolia*. Other common species here are *Euphorbia corollata*, *Rosa carolina*, and *R. subserrulata*.

This ravine formation develops in acid soil areas and as the headwaters enlarge the valley and ravine, the floras of the lower slopes and valley penetrate the richer slopes and ravine bottom of

FIG. 38. South-facing limestone bluffs along White River opposite Table Rock, Taney County, showing how a vertical cross section of this locality would include all stages in the development of a flood-plain association, through the stages leading to the coverage of a limestone slope, and eventually, over a cherty substratum, to the stages leading to the oak–hickory climax.

the new drainage with such species as pawpaw, American hornbeam (*Carpinus caroliniana*), spicebush, redbud, chinquapin oak, butternut, shagbark hickory, and mulberry, while the flora of the ridge tops, plateaus, and upper slopes descends somewhat and overlaps that of the ravine and drainage types. Thus, the flora may become very diversified as the head of a ravine is followed down its course. Red maple, sour gum, white oak, and mockernut hickory comprise the tallest dominants, with flowering dogwood, sassafras, and serviceberry forming the conspicuous understory. One sees this association developed in all the ravines having acid soils and on all acid soil slopes along the dissected courses of streams.

These associations have been traced according to their origin and place of development. While they have been discussed in detail separately and disconnectedly, it should be emphasized that they

are all contiguous and overlapping. A good example of the close proximity of the associations is in connection with a limestone bluff along a river course. A vertical cross section of this bluff might reveal several stages in the development of the flood-plain flora following the river (fig. 38), leading to a limestone bluff with its various associes from a limestone glade or eroded escarpment to a climax or semiclimax stand of sugar maple–white oak; while directly overlying the limestone bluff formation might occur an eroded chert or sandstone ridge covered by red maple–white oak or pine–oak association,

FIG. 39. Right half of picture in background in white is covered by *Juniperus virginiana* overlying a limestone substratum; left half of picture mixed oak and pine overlying chert substratum. Shows how two totally unlike associations may develop side by side if growing on certain substrata. Along highway No. 19, two miles north of Eminence, Shannon County.

and on the broader plateau portion away from the hill slope might occur a climax oak–hickory association.

Also, as a result of variations in substratum even on one hillside and in the degree of erosion of the substrata, part of an association may be in some stage of development located amidst another association. This is a common occurrence on some limestone slopes where chert has been exposed along a draw or has been eroded from the surrounding limestone formation. This natural admixture of associations often results in a mixture of the understory. The effect of the substratum upon the plant association which develops on it is well shown where one part of a hillside which has a limestone substratum develops the calciphilous red cedar associes, while adjacent to the latter on a cherty soil is developed the oxylophilous southern yellow pine associes (figs. 39 and 40).

SUBCLIMAX STAGES IN THE OZARKS

Throughout the study of natural succession in the Ozarks, various subclimax stages were observed in the different associations.

(*a*) There are two subclimaxes possible in the successional stages over an eroded limestone substratum covered eventually by a sugar maple–white oak association: (1) a red cedar subclimax, and (2) a chinquapin oak subclimax. The former (*Juniperus virginiana*) type may persist as long as eroded limestone bluffs or glades remain. Red cedar is a pioneer and monopolizer of such limestone-barren areas. Ozark uplifts followed by erosion have been the natural means of preserving such areas, which have been constantly occupied and reoccupied by cedar. As long as a bare rocky limestone substratum occurs, cedar will be its dominant occupant. Dynamiting of limestone areas to open up new exposures of rock, or artificial prevention of soil cover over the limestone barren are methods by which the area could be enlarged, if desired. Also, cutting so that only cedar is left will again bring on a cedar associes, since, being a light-demanding species, it will pioneer on open places.

(*b*) Another subclimax, that of chinquapin oak (*Quercus Muhlenbergii*) is reached on south- and west-facing limestone slopes. As already explained, the covering up of a red cedar glade eventually leads to dominance of the chinquapin oak stage. This may eventually culminate in the climax sugar maple, but a subclimax of the chinquapin oak may be reached on south- and west-facing slopes. At least, on such slopes chinquapin oak can last indefinitely because the greater exposure and drouth, and the windswept nature of such slopes, tend to keep chinquapin oak dominant and at the same time prevent sugar maple from encroaching upon such dry exposures.

(*c*) Another subclimax is reached in the development of the flood-plain flora. As will be recalled from discussions above, the flora of the flood-plain areas culminates in a sugar maple–bitternut hickory climax associes. It is possible before this climax stage is reached for a subclimax of elm in the elm–ash associes to be developed. A subclimax of elm may continue as long as conditions are unfavorable for the entrance of sugar maple into the associes (example No. 161). This may occur in several ways. If, for example, a flood-plain flora is developing within a region surrounded by acid soils of sandstone or chert, and the acid soils prevent entrance of sugar maple upon the slopes underlain by such rock, the elm in the valley would reach its dominance and not become eventually dominated by sugar maple, as would be the case if it were in a region surrounded immedi-

ately by limestone substrata. Also, a subclimax of elm would be reached in a region outside the distributional limits of sugar maple. Besides, in a flood-plain region developed where there are no rock exposures, such as in a prairie area, or in a flood plain in a late stage of valley development where the flood plain is several miles wide bordered by low hills with few or no outcrops, the subclimax of elm may be attained.

(*d*) Just as a subclimax of red cedar may be reached on an eroded limestone slope, so may a subclimax of southern yellow pine be

FIG. 40. Right half of picture in background in white is covered by *Juniperus virginiana* overlying a limestone substratum; left half of picture mixed oak and pine overlying chert substratum. Shows how two totally unlike associations may develop side by side if growing on certain substrata. Along highway No. 19, two miles north of Eminence, Shannon County.

attained on an eroded sandstone or chert slope, ledge, or bare rock exposure. Pine is a pioneer on such rocky ledges and once it has gained a foothold on these areas, it monopolizes and takes possession of them. As long as pine has the open rock free from other woody species and undisturbed so that it can continue to invade and reseed on such areas, it will remain dominant and uncontaminated and so form a pine subclimax. In other words, as long as pine has penetrated the acid rocky area first, and the thin, acid soils continue as such, pine will form a dominance of a subclimax stage. This natural pioneering of pine on undisturbed, light, open territory is the basis for an understanding of the past history and the future of pine in the Ozark forests. In the past there were undoubtedly more stands of pine of larger and in many cases purer extent than there are today. This is borne out by logging records, by reports by early geologists

and scientific observers throughout the Ozarks, such as those of Shumard and Broadhead, and by reports of older settlers and "old-timers" within the region. Some of the records of pure pine stands from the latter sources were, no doubt, exaggerated, since early lumbermen and settlers frequently judged as pure a stand composed of 80–90 per cent pine, or, in other words, were "pine-minded" where the pine occurred in thicker and purer stands. According to some settlers, the entire country was covered with pine. When such reports are more critically traced to their sources, it is usually discovered that pine was found on the upper slopes and narrower ridges while the ravine bottoms and broader plateau expanses were occupied by oaks and hickories.

The natural pine succession in itself helps to explain the previous greater dominance and abundance of pine. As has already been explained, as soon as black jack and other oaks penetrate a pine stand, that purity of stand is gone forever, since the various hardwoods continue to compete and the pine is unable to suppress their continued development, with the result that a mixed oak–pine forest is developed. The demand by pine for light plus no competition explains the reason why pine in the Ozarks today will not reseed itself to a pure pine stand in an existent oak–pine forest. But pure pine stands may be seen today where pine is spreading into bare, sterile, or fallow fields overlying acid soil, or onto bare, acid rocks, or over thin, acid soils recently exposed by burns, road cuts, or dynamiting. Since it is well known, by records of scientific travelers throughout the Ozarks, and by reports of settlers and surveyors, that many portions of the upland Ozark plateau now forested were open prairie a hundred years or more ago, and since many such upland areas included open sandstone or chert ledges or outcrops, it is reasonable to believe that pine in pure and large stands pioneered and occupied such open areas. Present areas of similar nature support a dense pine growth and it seems likely that past areas would have had the same ecologic expression.

While pines existed in denser and purer stands many years ago, there were nevertheless upland forests of oak and mixed oak–pine. The records of earlier surveyors and scientific travelers not only record the "pineries" but also call attention to upland forests of oak and oak–hickory, alternating with pine. The oak and oak–hickory association always has been common in the Ozark region, but as a result of lumbering the pine forests, oaks and hickories have penetrated more into the areas occupied by the latter and have become even commoner than previously. This also is borne out by earlier

settlers' observations. In other words, oak becomes a real rival to the pine, and the latter can merely hold its own, and is unable to seed itself to advantage or gain dominance once it becomes mixed with oak and hickory. If most of the oaks and hickories are cut, pine has a clearing again of open and light, more or less undisturbed territory, and will seed itself in such situations. This condition may readily be seen today in driving over highways in the Ozarks where pine seedlings may be observed pioneering on the bare, open, acid soils along the road.

The facts that today on bare or open, acid, sandstone or chert ledges or acid soil prairies, the blue-stem grasses (*Andropogon scoparius* and *A. provincialis*) dominate, and that these same grasses appear commonly in protected or unburned areas in pine and pine–oak forests, seem to offer proof that pine enters such prairie grass areas and that under a condition of an open forest these same grasses continue to grow (fig. 34). Thus, the forest has occupied and is occupying the prairie, and the blue-stem and other prairie grasses now found in pine and pine–oak and other forest types merely remind us of the former existence of that area as a prairie, rather than as a forest type. In other words, the forest has gradually been encroaching upon the prairie rather than vice versa.

As one goes northward and northwestward along the border of the Ozarks, pine becomes less and less conspicuous, while oaks and hickories become commoner. The chances of the occurrence of pure pine stands diminish as one goes toward the boundary of the Ozark region, while the chances of the occurrence of mixed pine–oak and oak–hickory stands increase. Thus, around the Dillard camp area in the Clark National Forest Purchase Unit and in other places in that region pine is absent, being too near its northern limit or as far as its past geological migration has permitted it to go. However, post and black jack oak and Ozark hickory in that region are supported by an upland acid soil, and pine could easily be planted on such a soil and could become common, provided the necessary light, open, undisturbed conditions could be given. This would apply elsewhere on existent acid soil areas.

PLANT INDICATORS OF ACIDITY AND ALKALINITY

On account of the unglaciated condition of the Ozarks, with residual soils and rock outcrops everywhere, the relationship between the occurrence of a species and its underlying substratum is very obvious. It is true that other factors, such as the exposure

of the slope, i.e. whether north or south, or the proximity to water, or exposure to sunlight, play an important rôle in affecting distribution of the various species, but the factor of the soil acidity in relation to the rock from which the soil has been derived appears to be the most important one in determining distributions of many species. This is most apparent wherever the soil is thin and the rock substratum is near the surface or exposed as bluffs, ledges, and the like. So frequently is the same species found on particular soils of an acid or alkaline reaction, that many species are actually indicators of certain types of soils.

The acid soils of the Ozarks are derived from sandstone, cherts, and flints, or granitic rocks, while the alkaline types originate from limestones and dolomites. The ridge tops and upper slopes of many of the hills in the Ozarks are mostly acid in soil reaction because they are underlain by either sandstones or cherts. This is one reason why pine occurs largely on ridge tops and upper slopes. The limestones, on the other hand, are exposed mainly as bluffs and in outcrops along the streams and from the bases of hills to two-thirds or three-fourths the way up the slope, and these give rise to alkaline soils. Draws in the heads of ravines which usually originate in the upper cherty portions of the upland are generally of an acid nature. Plant species of alkaline soils are often found on neutral soils as well. The alluvial soils and those found in the development of the flood-plain flora are usually types about neutral in reaction and there no plant indicators are found on them. White oak is found on all types of soils, both acid and alkaline, dry and rocky as well as alluvial, and does not indicate any particular acidity type.

(*a*) The following species in the Ozarks are *plant indicators* of *acid* soils, and where limited to certain associes the name of that associes is given immediately after the scientific name:

Agrostis (*Agrostis Elliottiana*)
Aster (*Aster linariifolius*)
Bastard toadflax (*Comandra Richardsiana*)
Bedstraw (*Galium arkansanum*)
Bedstraw (*Galium pilosum*)
Black jack oak (*Quercus marilandica*)
Black or sour gum (*Nyssa sylvatica*)
Blue curls (*Trichostema dichotomum*)
Blue-stem (*Andropogon scoparius* var. *genuinus*)
Bluet (*Houstonia longifolia*)
Bracken (*Pteridium latiusculum*)
Broom sedge (*Andropogon Elliottii*)
Broom sedge (*Andropogon virginicus* var. *genuinus*)
Bulbostylis (*Bulbostylis capillaris*)
Bush clover (*Lespedeza hirta*)

Bush clover (*Lespedeza procumbens*)
Bush clover (*Lespedeza repens*)
Bush clover (*Lespedeza virginica*)
Catgut, hoary pea (*Tephrosia virginiana*)
Cinquefoil (*Potentilla canadensis* var. *villosissima*)
Cinquefoil (*Potentilla simplex*)
Crotonopsis (*Crotonopsis elliptica*)
Dropseed (*Sporobolus vaginiflorus*)
Early bunch grass (*Sphenopholis nitida*)
Fall witch grass (*Leptoloma cognatum*)
False dandelion (*Krigia Dandelion*)
Farkleberry (*Vaccinium arboreum* and var. *glaucescens*)
Goldenrod (*Solidago hispida*)
Greenbrier (*Smilax glauca* var. *leurophylla*)
Harvey's buttercup (*Ranunculus Harveyi*)
Hedgehog club-rush (*Cyperus filiculmis*)
Hedgehog club-rush (*Cyperus ovularis*)
High-bush huckleberry (*Vaccinium stamineum* and var. *neglectum*)
Indian grass (*Sorghastrum nutans*)
Knotweed (*Polygonum tenue*)
Ladies' tobacco (*Antennaria plantaginifolia*)
Liverleaf (*Hepatica americana*)
Low-bush huckleberry (*Vaccinium vacillans* and var. *crinitum*)
Mockernut hickory (*Carya tomentosa*)
Ozark hickory (*Carya Buckleyi* var. *arkansana*)
Panic grass (*Panicum depauperatum*)
Panic grass (*Panicum dichotomum*)
Panic grass (*Panicum lanuginosum* var. *fasciculatum*)
Panic grass (*Panicum linearifolium*)
Panic grass (*Panicum perlongum*)
Panic grass (*Panicum sphaerocarpon*)
Paspalum (*Paspalum ciliatifolium* var. *Muhlenbergii*)
Pencil flower (*Stylosanthes biflora*)
Pine-weed (*Hypericum gentianoides*)
Pinweed (*Lechea tenuifolia*)
Pinweed (*Lechea villosa*)
Post oak (*Quercus stellata*)
Poverty grass (*Aristida dichotoma*)
Red maple (*Acer rubrum*)
Rough buttonweed (*Diodia teres*)
Rush (*Juncus marginatus*)
St. Andrew's cross (*Ascyrum hypericoides* var. *multicaule*)
Scarlet oak (*Quercus coccinea*)
Sedge (*Carex artitecta*)
Sedge (*Carex hirsutella*)
Sedge (*Carex umbellata*)
Sensitive pea (*Cassia nictitans*)
Serviceberry (*Amelanchier canadensis*)
Slender fescue grass (*Festuca octoflora* var. *tenella*)
Southern red oak (*Quercus falcata*)
Southern yellow pine (*Pinus echinata*)
Spiderwort (*Tradescantia longipes*)
Star violet (*Houstonia pusilla*)
Sundrops (*Oenothera linifolia*)
Tick trefoil (*Desmodium laevigatum*)
Tick trefoil (*Desmodium marilandicum*)

Tick trefoil (*Desmodium nudiflorum*)
Tick trefoil (*Desmodium obtusum*)
Tick trefoil (*Desmodium rotundifolium*)
Triple-awned grass (*Aristida oligantha*)
Turkey pea (*Clitoria mariana*)
Violet (*Viola triloba* and var. *dilatata*)
Wild honeysuckle, pink azalea (*Rhododendron nudiflorum* var. *roseum*)
Wild oats grass (*Danthonia spicata*)
Woodrush (*Luzula campestris* var. *bulbosa*)
Yellow star grass (*Hypoxis hirsuta*)

(*b*) The following species in the Ozarks are *plant indicators* of *alkaline* soils, and where limited to certain associes, the name of that associes is given immediately after the scientific name:

Asclepiodora (*Asclepiodora viridis*); *Bouteloua–Rudbeckia* associes
Bedstraw (*Galium virgatum*); cedar associes
Blue ash (*Fraxinus quadrangulata*); chinquapin–ash associes
Buckthorn (*Rhamnus lanceolata*)
Calamint (*Satureja glabella* var. *angustifolia*); *Bouteloua–Rudbeckia* associes
Chinquapin oak (*Quercus Muhlenbergii*); chinquapin–ash associes
Chittim-wood (*Bumelia lanuginosa*)
Cowbane (*Oxypolis rigidior*)
Crosswort (*Lysimachia longifolia*)
Early meadow rue (*Thalictrum dioicum*)
Evolvulus (*Evolvulus Nuttallianus*); *Bouteloua–Rudbeckia* associes
False aloe (*Agave virginica*); *Bouteloua–Rudbeckia* associes
Wood's hellebore (*Veratrum Woodii*)
False pennyroyal (*Isanthus brachiatus*)
Feverfew (*Parthenium hispidum*); *Bouteloua–Rudbeckia* associes
Goldenrod (*Solidago Drummondii*)
Grass-of-parnassus (*Parnassia grandifolia*)
Heliotropium (*Heliotropium tenellum*); cedar associes
Houstonia (*Houstonia nigricans*); cedar associes
Indian cherry (*Rhamnus caroliniana* var. *mollis*); cedar associes
Kentucky blue grass (*Poa pratensis*)
Leavenworthia uniflora; Bouteloua–Rudbeckia associes
Liverleaf (*Hepatica acutiloba*)
Melic grass (*Melica nitens*); cedar associes
Missouri primrose (*Oenothera missourensis*); cedar associes
Mountain mint (*Pycnanthemum virginianum*)
Prairie clover (*Petalostemum purpureum*); *Bouteloua–Rudbeckia* associes
Red cedar (*Juniperus virginiana*)
Rudbeckia (*Rudbeckia palustris*)
Running strawberry-bush (*Euonymus obovatus*)
Rush (*Juncus diffusissimus*)
Sandwort (*Arenaria patula*); *Bouteloua–Rudbeckia* associes
Satin grass (*Muhlenbergia sobolifera*)
Schneck's red oak (*Quercus Shumardii* var. *Schneckii*); chinquapin–ash associes
Scurfy pea (*Psoralea tenuiflora*); cedar associes
Sedge (*Carex eburnea*)
Sedge (*Carex leptalea*)
Side-oats grama grass (*Bouteloua curtipendula*)
Slippery elm (*Ulmus fulva*)
Sugar maple (*Acer saccharum* var. *glaucum*)
Tansy mustard (*Descurainia pinnata* var. *brachycarpa*)

Umbrella grass (*Fuirena simplex*)
Vervain (*Verbena simplex*); cedar associes
Whitlow Grass (*Draba cuneifolia*); *Bouteloua–Rudbeckia* associes
Widow's cross (*Sedum pulchellum*)
Wild columbine (*Aquilegia canadensis*); chinquapin–ash associes
Wild onion (*Allium stellatum*); cedar associes

Most of the acid soil indicators occur in woods of either red maple–white oak, oak–pine, or oak–hickory associes. Those most indicative of calcareous soils are found, especially in the first few stages, in the covering of the limestone glade, first the limestone glade, then the "cedar" stage, and finally on to the chinquapin oak and eventually sugar maple stage.

ECOLOGICAL VARIATIONS INDUCED BY BURNING, LOGGING, CLEARING, AND OTHER UNNATURAL CAUSES

The various units and their succession as above discussed represent the natural and typical manner in which the vegetation has developed. There have, however, been various factors at work, such as burning, overgrazing, logging, and erosion, which have often helped to change the natural aspect of the succession. The present picture, therefore, in places, represents a hodgepodge, because while the association is still recognizable as a unit, the component species of its various stages have been suppressed at one time or in one section while accelerated at another period or in some other portion. This has led to an unbalanced and often unnatural appearance of the association. The various factors which cause this variation also work unevenly. Burning alone may cause certain changes in the normal course and rate of development, while over-grazing or logging alone may effect still other changes. When, however, instead of one of these acting alone there is a combination of burning, logging, and over-grazing, the effect of an unequal rate of development of the various species may be visualized.

Burning.—Burning has very definite results on succession. In taking stock of burns both the forest cover and the herbaceous ground flora must be considered; too frequently only the effect on the former has been stressed. Spring burns do considerably less damage than summer burns, so far as the effect on the succession is concerned, as they only retard it or keep it at a standstill. The herbaceous ground flora does not suffer extensively from a spring burn; a few of the more tender species may perish here and there as a result of diminished humus cover, but in general the ground cover remains at a standstill from year to year (fig. 41). The effect of spring burns on the forest and understory is even less than that

on the herbaceous ground cover. The trees and shrubs after spring burns throw out new foliage; some become scorched here and there, but the killing effect is negligible. The quality of the timber does not suffer nearly as greatly from spring burns as from the scarred effects left on the wood by summer burns. Repeated annual spring burning for a few years merely destroys the yearly leaf litter, and thereby keeps the soil light and more or less open, preventing the accumulation of a dense leaf litter. This naturally allows those species which

FIG. 41. Effect of a spring burn, showing a very light density of forest floor coverage. Note the open patches of soil between the herbs. Twelve miles north of Poplar Bluff, T. 26 N., R. 7 E., sec. 20 and 21, Butler County.

favor light, open ground, relatively free from leaves, to become commoner and more or less dominant.[1]

Gradually, however, annual spring burnings wear down the soil cover, and if continued over many years—perhaps 20 or 30—soil may be worn down to its underlying rock substratum, which in the

[1] At this point it may be stated that most of the burns observed occurred on acid soil substrata, either upland slopes, ridges, and broad plateaus, or ravines and draws in acid soil areas; therefore, in the oak–hickory, red maple–white oak, or oak–pine associations. No burns were observed within the limestone soil areas of the sugar maple–white oak association. This may be due to the fact that most of the limestone areas are in broken, rough country in the form of bluffs or glades, usually next to streams, a type of country seldom fired by the Ozark people, while the commonly fired hilltops and adjoining uplands and ravines have an underlying acid substratum of eroded chert, flint, or sandstone. Thus, there are perpetuated upon such places species found on light, open, acid soils, such as catgut (*Tephrosia virginiana*), dittany (*Cunila origanoides*), pussy toes (*Antennaria plantaginifolia*), horsemint (*Monarda Bradburiana*), bracken fern (*Pteridium latiusculum*), and various species of *Lespedeza* and tick trefoil (*Desmodium rotundifolium, D. Dillenii, D. marilandicum, D. obtusum*, and others), sensitive pea (*Cassia nictitans*), cinquefoil (*Potentilla simplex*), and oats grass (*Danthonia spicata*).

case of much of the Ozarks is Roubidoux sandstone or chert. Thus, in many parts of the Ozark region many flinty hills are so exposed that they resemble a barren rock pile. In such cases the soil is worthless and will support only a sparse cover, much more sparse than before, and this sparse cover is very often dominated by the worthless oats grass (*Danthonia spicata*). If practiced for many years, spring burning leads eventually to destruction of a soil cover and causes the herbaceous ground cover to revert to an earlier stage of succession.

FIG. 42. Damage done by summer burn, along highway No. 49, just south of Black, Reynolds County. The burn occurred on June 25 and the picture was taken August 14 of the same year. Note how the area was burned down to the chert substratum, and how the sumac (*Rhus Copallina*) has already sprouted at the bases of the stems.

The effect of a spring burn on the succession is rather slow compared with that of a summer burn. Summer burns cause serious scars on the bark which leave impressions in the wood, so that its

quality is injured. Summer burns do not kill the older trees but only the lower branches of some of the younger ones, but very often one-year-old to twenty-year-old saplings are killed. Saplings are killed from the tops to the base of the stem, and if they come back thereafter, it is from the sprouting of underground shoots (fig. 42).

FIG. 43. Same burn shown in Fig. 42. Note damage done to the herbaceous vegetation.

The understory succession may be set back from one to twenty years as a result of a summer burn. Usually a summer burn throws back the stage of succession only a few years.

The effect of a summer burn on the herbaceous ground cover is much more abrupt and deteriorating (fig. 43). The more tender herbaceous growth is killed outright and many species usually do not recover enough to come up again from sprouts. Thus many species are lost in that area for a while and may not return for many years, and in the case of some selective types, may never return. As a rule,

however, members of the Leguminosae, Compositae, Euphorbiaceae, and Gramineae survive summer burns sufficiently to come back from underground shoots. Species of *Lespedeza* and *Desmodium*, catgut (*Tephrosia*), *Rosa*, *Antennaria*, *Panicum*, *Danthonia*, *Carex*, winged and smooth sumacs (*Rhus Copallina* and *R. glabra*), flowering spurge (*Euphorbia corollata*), and a few others come up again after summer burns. The succession of the herbaceous ground cover is, however, set back several years, because summer burns wear the soil away to the rocky substratum stage so much sooner (fig. 42), and the more this condition is approached, the more rapidly the earlier stages of ground vegetation are reached.

These spring and summer burns do not at the time of their occurrence destroy all the herbaceous ground cover of an area. Most of it is taken, but patches here and there are left untouched, and species from these unburned patches have the advantage of reproducing their kind over the barren area without much interference, so that certain species sooner or later may dominate the burned areas. Summer burns may be said to wear down the soil cover more rapidly than spring burns and throw back the succession more quickly to an earlier stage of development.

Burning in general has a deteriorating effect by diminishing most of the palatable forage grasses, and this is an important issue in the entire question of burns. The grass that used to be the commonest and best range grass in the Ozarks was blue-stem (*Andropogon scoparius* mostly, with some *A. provincialis*). This covered large tracts in open oak–hickory and oak–pine woodlands and occurred in great density. Blue-stem and broom sedge (*Andropogon virginicus*), species of *Panicum*, *Sorghastrum nutans*, and species of *Carex* (*C. artitecta*, *C. hirsutella*, and others), were common. Wild oats grass (*Danthonia spicata*) was much less common then than today, because the other grasses prevented its development. As fires increased and annual burning became commoner with increased settlement, the density of the important grasses became less and less. Finally, in many places the stage was reached where bare, open places existed, and became commoner as grass and other herbage grew less dense. This type of light, open, rocky soil habitat became the territory which wild oats grass (*Danthonia spicata*) most favored. It increased in such open, rocky areas and in time became dominant, until now it is the commonest grass of the upland acid slopes and ridges. It is not a good forage grass, and its establishment on light, open, rocky soil areas caused by burning indicates the harm caused by repeated and un-

controlled burning. If the people in the Ozarks burn their forests to get a cover of more grass for forage, they are being deceived into believing that oats grass is good, while as a matter of fact it is inferior.

The rate of deterioration or reversion to an earlier and earlier stage of the ground cover is directly influenced by the slope gradient. In

FIG. 44. Flat ridge top in *Quercus alba–Quercus stellata* woodland, four miles northwest of Bunker, Reynolds County. Note thick leaf covering with resultant scarcity of undergrowth.

the case of a steep slope, the soil is worn down much more rapidly to flint or sandstone than in that of the flat upland ridge or plateau. With the latter a very much longer period of time is required to wear the ground down to a rock substratum.

Shading and the density of leaf litter on the ground have definite effects on the herbaceous ground flora. For the most part, shading and a dense ground cover produce a sparse ground flora, and a sparse

grass flora in particular. The following conditions serve to show the various types found within the Ozarks:

(1) If the soil has been worn down as a result of *continued fires* to the *flinty* or *sandstone substratum*, and at the same time the *woods* are *more* or *less* open, the herbaceous cover is poor and the inferior oats grass (*Danthonia spicata*) is dominant among the grasses present.

(2) If the soil as a result of *scattered burns* has been worn down so that it is still *intact* but also *rocky* and at the same time the woods

FIG. 45. *Quercus alba–Quercus velutina–Quercus stellata* woodland on flat ridge top, four miles northwest of Bunker, Reynolds County, near ridge top shown in Fig. 44. Note the dense sprout undergrowth, but poor herbaceous ground flora.

are more or less open, the result is usually a rich and dense herbaceous vegetation with grasses and legumes dominating, and usually the better forage grasses, such as blue-stem (*Andropogon scoparius* and *A. provincialis*) and panic grasses, predominate, while oats grass is inconspicuous. This is a desirable condition.

(3) If the soil on a flat upland *ridge* or *plateau* is *built up* and covered by a *dense forest* of younger trees, the effect of shade and at the same time a dense leaf litter, is such as to produce a very sparse ground flora, the grasses being almost negligible (fig. 44).

(4) If a forest such as is found in the preceding type, with *built-up soil*, is *burned over* and a *dense stump sprout* growth springs up, the sprouts act as wind-breaks and allow dense coverings of leaves to accumulate in their vicinity. Wherever these dense leaf piles appear, the grasses are absent, especially oats grass. Some legumes, such as *Lespedeza procumbens*, may be present, but the flora as a whole is

sparse. Only in light and rocky openings, between leaf piles or where rock is exposed, or around the bases of trees, does the ground flora become denser.

(5) In areas *protected from burns* and at the same time with an *open woodland*, a variety of grasses return and in time approach their original dense growth.

(6) In areas protected from burns but with a *dense, crowded woodland*, the shade and leaf litter are too great for a rich ground flora, and consequently the herbaceous flora is very poor, especially in grasses (fig. 45). The ground cover may then be dominated by the shade-enduring low-bush huckleberry (fig. 35).

It appears that the densest growth of grasses of the better forage type is found in *open woods* protected from fire with a light, semi-rocky soil not extensively covered with leaf litter. If an area is repeatedly burned down, eventually to a rock substratum, oats grass becomes the most conspicuous grass.

A light, open, rocky soil also harbors a rich variety of legumes, many of which favor such a rocky, thin, open substratum. Thus, after continued burning with reduction of soil, such species increase in numbers because of an increase in their habitats. It is therefore incorrect to speak of such species as indicators of burning; rather they are species which appear in areas opened up by burning. The various herbs which are characteristic or commonest in areas opened by burns, or which tolerate burns, are the following:

Bracken fern (*Pteridium latiusculum*)
Bush clover (various species) (*Lespedeza procumbens, L. repens, L. hirta,* and *L. virginica*)
Catgut (*Tephrosia virginiana*)
Cinquefoil (*Potentilla simplex* var. *typica*)
Dittany (*Cunila origanoides*)
Fleabane (*Erigeron ramosus*)
Flowering spurge (*Euphorbia corollata*)
Forked chickweed (*Paronychia fastigiata*)
Greenbrier (*Smilax glauca* var. *leurophylla*)
Horsemint (*Monarda Bradburiana*)
Ironwood (*Vernonia Baldwini*)
Japanese clover (*Lespedeza striata*)
Pencil flower (*Stylosanthes biflora*)
Pennyroyal (*Hedeoma pulegioides*)
Pinweed (*Lechea tenuifolia*)
Pussy toes (*Antennaria plantaginifolia*)
Rose (*Rosa subserrulata*)
Sensitive pea (*Cassia nictitans*)
Sweet everlasting (*Gnaphalium obtusifolium*)
Tick trefoil (various species) (*Desmodium rotundifolium, D. obtusum,* and *D. Dillenii*)
Wild indigo (*Baptisia leucantha* and *B. leucophaea*)

It will be seen that a great majority of these species belong to the pea and composite families. Catgut, dittany, greenbrier, *Lespedeza procumbens*, and *Desmodium rotundifolium* are especially common.

The grasses which are commonest in such burned areas are the following:

Oats grass
Species of *Panicum* (*P. dichotomum* and *P. lanuginosum* var. *fasciculatum*)
Hair grass (*Agrostis scabra*)
Sedge (*Carex hirsutella*)

In woods which have been burned over and opened up, winged sumac (*Rhus Copallina*) and sassafras are the commonest woody plants to enter and consequently are indicators of burning in that sense.

If, as these studies indicate, a great variety and density of leguminous species appear on light, thin soils of the rocky, open type—the type most directly produced by burning, especially summer burns—it might be advantageous on turkey ranges or other similar areas where leguminous foods are of high value, to burn, under controlled management, every five to ten years in order to revert the herbaceous ground cover to an earlier stage of succession where the leguminous flora will be at its maximum development. If this is not done, the natural succession of the ground flora, where fires are eliminated and where leaves consequently would accumulate and shade increase, would be towards a suppression of grasses and legumes, resulting in less abundance of turkey food.

Logging.—The effects of burning are thus found to be varying in degree and must be considered from different angles. The effects of logging on the natural succession of a forest are equally interesting. When tall trees are removed from a forest, the result is an open, sunny place where previously more or less shaded conditions existed. This creates a habitat within the forest equivalent to a prairie opening, and allows species which favor open and sun-lit conditions to enter, penetrate, or spread. Very often some species which come in on repeatedly cleared areas are the same as appear in burned-over areas, because similar habitats are created by burning and repeated clearing. In the case of a minor amount of cutting in a forest, done only rarely, the migration into that area of light-demanding species is not great. However, where repeated clearing continues, a number of species are commonly found which are more or less characteristic of open areas. The herbaceous species which may be called indicators

of repeated clearing, although they are merely species coming in on light, open soils, are the following:

Bitterweed (*Helenium tenuifolium*)
Black-eyed Susan (*Rudbeckia hirta*)
Bracken fern (*Pteridium latiusculum*)
Broom sedge (*Andropogon virginicus*)
Bush clover (*Lespedeza virginica*)
Buttonweed (*Diodia teres*)
Dewberry (*Rubus flagellaris*)
Everlasting (*Gnaphalium purpureum*)
Field sorrel (*Rumex Acetosella*)
Fleabane (*Erigeron ramosus*)
Flowering spurge (*Euphorbia corollata*)
Forked chickweed (*Paronychia fastigiata*)
Greenbrier (*Smilax glauca* var. *leurophylla*)
Ironweed (*Vernonia Baldwini*)
Japanese clover (*Lespedeza striata*)
Mullein (*Verbascum Thapsus*)
Pennyroyal (*Hedeoma pulegioides* and *H. hispida*)
Pinweed (*Lechea tenuifolia*)
Pussy toes (*Antennaria plantaginifolia*)
Thistle (*Cirsium lanceolatum*)
Wild indigo (*Baptisia leucantha* and *B. leucophaea*)
Wild petunia (*Ruellia caroliniensis*)
Yarrow (*Achillea Millefolium*)
Yellow hop clover (*Trifolium procumbens*)

The commonest species which appear on such areas are bitterweed, yarrow, greenbrier, and flowering spurge. Oats grass is by far the commonest of the grasses. Among the commonest shrubs are smooth sumac (*Rhus glabra*) and winged sumac (*Rhus Copallina*). Sassafras, persimmon, post and black jack oak, and winged elm are the only trees which are commonly found in or come into repeatedly cleared areas. The first woody species to spread into an opening in a forest induced by repeated clearing or logging are the smooth and winged sumac and sassafras. The natural home for these species is open prairie, borders of woods, or openings in woods. Thus, when conditions are created within a forest by clearing which establish an open habitat, these shrubs and trees are first to pioneer in response to their light-demanding requirements.

Repeated Clearing and Logging.—The effects of repeated clearing and logging are not as harmful as repeated burning. Logging and clearing merely open up the soil cover and understory, but do not materially disturb the understory or reduce the soil cover to the bare substratum as does repeated burning. If grasses of the better forage type are already present in sufficient numbers when the clearing occurs, they are thereby benefited, because new open places and an increase of favorable habitats are created. Thus, under such con-

ditions, grasses will increase in density, as will also legumes and composites and other light-demanding herbs. If, however, the soil has been worn down badly as a result of repeated burns, and the area is simultaneously or subsequently cut over, the worthless oats grass (*Danthonia spicata*) becomes more plentiful. In many instances it was observed that grasses were most plentiful and in greatest density in areas which had been opened up by logging but protected from fires. Thus, for best grazing ranges, it might be advantageous to cut over in part and at different times an area already covered with good forage grasses, so as to create more openings and sun-lit areas to be occupied by an increasing number of grass species.

Repeated clearing and logging result in such a mixture and confusion in the natural forest succession that it is at times difficult to interpret the stage at which it has arrived in a given forest. Therefore certain species are thinned out, and instead of the succession carrying on toward the climax stage, the earlier species of the succession may become once more dominant, and the previous dominant species may become temporarily suppressed. Thus, a temporary standstill or reversion may occur. In time, however, the species originally dominant usually persist and, if left to grow again from saplings or sprouts, finally enter the climax stages of the association.

Over-Grazing.—Many portions of the Ozark region are overgrazed. These areas usually occur on the upland. Usually a greater number of animals is turned loose over an area than can be supported on that area. The average density of the herbaceous ground cover varies according to different influences. The density of an herbaceous cover under a dense, unburned post oak–black jack oak stand is always very poor; that under an unburned, open, oak–hickory or pine–oak association is usually better; that of a logged but unburned area is usually good; that under an annually burned-over, open woods is usually quite poor, as is also one under a very much cut-over and burned-over woods. Since the normal density is not great, and does not average very much in an ordinary open oak–hickory or pine–oak forest, it is easy to allow too many animals to graze in such an area. When, in addition, open range hogs are turned loose to grub roots and eat herbage and nuts of various kinds indiscriminately, their effect on making a low density even lower should be emphasized. There is too much grazing on a limited amount of land in the Ozarks already. When it is considered that excessive over-burning in cut-over or non-cut-over areas lowers the ordinary density of herbaceous growth within a forest, and when to this is added the burden of over-

grazing, it is evident that the already sore conditions may be further aggravated. The Ozarks, if properly protected from fire and too much grazing, may afford valuable pasturage, a high density yield being possible in an open oak–hickory or oak–pine association. If too frequent burning and over-grazing are permitted, the low density at present encountered may be expected to continue. And in many areas in the Ozarks grazing in the uplands and slopes is not now practicable on a large scale.

When an upland area that has been cleared or cut over is then grazed, the constant cropping of herbage by too many cattle during summer leads to deterioration of the herbaceous cover, which in time becomes thinned out, exposing numerous bare patches of ground. When this condition has been reached, various species, mostly weedy and colonizing types, take possession. These are indicators of over-grazing, and may be the same as those on a sterile or fallow field.

The herbs which indicate over-grazing, because they are the ones which remain in a grazed-over area after the more delicate species have been eaten or have perished, are:

Bitterweed (*Helenium tenuifolium*)
Blue vervain (*Verbena stricta*)
Bracted plantain (*Plantago aristata*)
Dwarf fleabane (*Erigeron divaricatus*)
English plantain (*Plantago lanceolata*)
Everlasting (*Gnaphalium purpureum*)
Field sorrel (*Rumex Acetosella*)
Hairy pennyroyal (*Hedeoma hispida*)
Hogwort (*Croton monanthogynus*)
Horse nettle (*Solanum carolinense*)
Japanese clover (*Lespedeza striata*)
Lesser ragweed (*Ambrosia bidentata*)
Mullein (*Verbascum Thapsus*)
Pinweed (*Lechea tenuifolia*)
Plantain (*Plantago elongata*)
Rough buttonwood (*Diodia teres*)
Rush (*Juncus macer*)
Sundrops (*Oenothera linifolia*)
Sweet everlasting (*Gnaphalium obtusifolium*)
Thistle (*Cirsium lanceolatum*)
White boneset (*Eupatorium serotinum*)
Yarrow (*Achillea Millefolium*)
Yellow hop clover (*Trifolium procumbens*)

The following grasses are characteristic indicators of over-grazing:

Crab grass (*Digitaria sanguinalis*)
Elliott's hair grass (*Agrostis Elliottiana*)
Fescue grass (*Festuca octoflora* and var. *tenella*)
Hair grass (*Agrostis scabra*)
Poverty grass (*Aristida dichotoma*)
Sporobolus vaginiflorus
Triple awn grass (*Aristida oligantha*)

Winged sumac (*Rhus Copallina*), sassafras, and winged elm are woody species that indicate over-grazing. These species all enter areas which have been over-grazed.

Interestingly enough, most of these species occur also on open, rocky, sandstone or chert or granite glades. In other words, the same conditions of thin, bare, worn-down, or acid soils prevail on both barrens of acid rock and on over-grazed fields. An over-grazed soil usually becomes worn down to the extent that bare patches of soil exist with stunted herbage; this type of condition approaches a glade in its sterile, open, dry, wind-swept soil, and thus, species favoring such areas pioneer quickly on such types.

Other Unnatural Conditions.—During dry summers in the Ozarks, cattle were observed to have an injurious effect on the vegetation of natural sink-hole ponds. Within certain parts of the eastern Ozarks, particularly in Reynolds, Shannon, Oregon, Texas, and Howell counties, are many such ponds. During ordinary seasons they usually remain filled with water. Most of those that dried up during the summer might have retained water had it not been for the cattle, which were allowed to wade in and out at any time; every time they emerged they took away water. Ordinarily evaporation during a summer merely reduces the water level, but does not dry up the pond. However, cattle shuffling in and out of the ponds caused many of the ponds to dry up completely. As the ponds become dried, the plants existing on the tussocks of sedges or in the lower crotches of shrubs are killed, both by lack of water and by being eaten by the cattle. Many of these plants at ordinary times furnish excellent forage, but when over-grazed and eaten to the roots by cattle, they are badly injured or killed. Since in these ponds many rare species of plants exist which are found nowhere else in the state, some way should be devised to prevent cattle from ruining the plants that serve as food for turkey, quail, duck, and other upland game life of the region.

The natural succession here is a series of stages eventually leading to a filling up of the pond and the establishment of a mesophytic forest thereon, and since such destructive over-grazing and drying up of these ponds by mismanagement of cattle grazing on them hastens their extinction, it seems highly important that steps be taken to protect ponds. Such ponds are valuable water reservoirs for game in the national forests, and every effort should be taken to keep cattle from destructive "stamping" in and out of the water from the pond.

Each of the following localities visited by the writer illustrates some special stage of development of a plant association discussed in the present paper. Usually the most conspicuous members of the plant association are listed under dominant trees or shrubs, and dominant herbaceous plants, as well as sub-dominants wherever it has seemed pertinent. The species listed as dominant are the most numerous in a given area.

Herbarium specimens of all the examples of plant associational cross sections in the following pages are to be found in the Herbarium of the Missouri Botanical Garden and the Herbarium of Field Museum of Natural History.

I. ACER SACCHARUM–CARYA CORDIFORMIS ASSOCIATION

(1) **Salix longipes** var. **Wardii–Hamamelis vernalis** Associes

1. Gravel bar at Hall's Bluff, south of Davidson's Blue Spring along Black River, sec. 4, T. 27 N., R. 4 E., four miles southeast of Mill Spring, Wayne County.

Dominant Trees

Ward's willow (*Salix longipes* var. *Wardii*)
Sycamore (*Platanus occidentalis*)

2. Porphyritic stream bed in "shut-in" along Telleck Branch, sec. 23, T. 35 N., R. 1 E., three and one-half miles northwest of Shepherd, Iron County.

Dominant Tree

Sycamore (*Platanus occidentalis*)

Dominant Shrubs

Ward's willow (*Salix longipes* var. *Wardii*)
Ozark witch hazel (*Hamamelis vernalis*)
Smooth alder (*Alnus rugosa*)

Associate

Sand grape (*Vitis rupestris*)

3. Gravel bar along Big Piney River between Dial's Camp, east of Big Piney and Ormsby's Place at Spring Creek crossing, T. 34–35 N., R. 10–11 W., Pulaski County.

Dominant Woody Plant

Ward's willow (*Salix longipes* var. *Wardii*)

Dominant Herbaceous Non-Grass Plants

Water willow (*Dianthera americana*)
Chairmaker's rush (*Scirpus americana*)

4. Rocky stream bed along Noblett Creek, sec. 19, T. 26 N., R. 10 W., eight miles west of Burnham, Howell County.

Dominant Shrubs

Ward's willow (*Salix longipes* var. *Wardii*)
Smooth alder (*Alnus rugosa*)
Swamp dogwood (*Cornus obliqua*)
Ozark witch hazel (*Hamamelis vernalis*)

5. Gravelly part of Piney Creek, sec. 19, T. 23 N., R. 24 W., five miles southwest of Cape Fair, Stone County.

Dominant Shrubs

Ozark witch hazel (*Hamamelis vernalis*)
Possum haw (*Ilex decidua*)

Other Shrub Associates

Hop hornbeam (*Ostrya virginiana*)
Rough-leaved dogwood (*Cornus asperifolia*)
Swamp dogwood (*Cornus obliqua*)
Ninebark (*Physocarpus opulifolius* var. *intermedius*)

6. Gravel bar along Pomme de Terre River, three miles northeast of Elkland, Hickory County.

Dominant Shrub

Ward's willow (*Salix longipes* var. *Wardii*)

Dominant Herbaceous Non-Grass Plant

Water willow (*Dianthera americana*)

7. Gravel bar along Osage River, sec. 2, T. 40 N., R. 13 W., west of Capps, Miller County.

Foxtail grass (*Setaria lutescens*)
Panic grass (*Panicum virgatum*)
Witch grass (*Panicum capillare*)
Spurge (*Euphorbia serpens*)
Lady's thumb (*Polygonum pensylvanicum*)
Spurge (*Euphorbia supina*)

8. Dry gravel bar along headwaters of Meramec River, sec. 14, T. 33 N., R. 4 W., two miles southeast of Max, Dent County.

Dominant Shrubs

Swamp dogwood (*Cornus obliqua*)
Ninebark (*Physocarpus opulifolius* var. *intermedius*)
Sand grape (*Vitis rupestris*)
Shrubby St. John's-wort (*Hypericum prolificum*)
Sassafras (*Sassafras albidum*)

Dominant Herbaceous Non-Grass Plants

Flowering spurge (*Euphorbia corollata*)
Tick trefoil (*Desmodium sessilifolium*)
Star tickseed (*Coreopsis pubescens*)
Bush clover (*Lespedeza virginica*)
Bush clover (*Lespedeza capitata*)

Dominant Grass

Panic grass (*Panicum virgatum*)

9. Gravel bar along Salt River, at Asher Ford, south of Spalding, Ralls County.

Dominant Woody Plants

Ward's willow (*Salix longipes* var. *Wardii*)
Sycamore (*Platanus occidentalis*)

Dominant Herbaceous Non-Grass Plant

Water willow (*Dianthera americana*)

Other Herbaceous Non-Grass Plant Associates

Small white morning glory (*Ipomoea lacunosa*)
Lady's thumb (*Polygonum lapathifolium*)
Lady's thumb (*Polygonum pensylvanicum*)
Smartweed (*Polygonum punctatum*)
Smartweed (*Polygonum Hydropiper* var. *projectum*)
Wild bean (*Strophostyles helvola*)
Water hemp (*Acnida tamariscina*)
Mule tail (*Erigeron canadensis*)
Carpet weed (*Mollugo verticillata*)
Nodding spurge (*Euphorbia maculata*)
Sida (*Sida spinosa*)
Small ragweed (*Ambrosia artemisiaefolia* var. *elatior*)

Dominant Grasses

Panic grass (*Panicum virgatum*)
Slough grass (*Spartina pectinata*)
Big blue-stem (*Andropogon provincialis*

Other Grass Associates

Panic grass (*Panicum dichotomiflorum*)
Love grass (*Eragrostis cilianensis*)
Crab grass (*Digitaria sanguinalis*)

10. Gravel bed of Little Fourche à Renault Creek, sec. 2, T. 37 N., R. 1 E., two miles southeast of Floyd, Washington County.

Dominant Trees

Sycamore (*Platanus occidentalis*)
Persimmon (*Diospyros virginiana*)

Dominant Understory

Swamp dogwood (*Cornus obliqua*)
Ward's willow (*Salix longipes* var. *Wardii*)
Sand grape (*Vitis rupestris*)
Ninebark (*Physocarpus opulifolius* var. *intermedius*)
Buck brush (*Symphoricarpos orbiculatus*)
Shrubby St. John's-wort (*Hypericum prolificum*)
Rough-leaved dogwood (*Cornus asperifolia*)
Black haw (*Viburnum rufidulum*)

(2) **Acer saccharinum–Populus deltoides** Associes

11. Alluvial banks along Black River between Mill Spring and Williamsville, sec. 30, T. 27 N., R. 5 E., Wayne County.

Dominant Trees

Cottonwood (*Populus deltoides*)
Sycamore (*Platanus occidentalis*)

Dominant Understory

Ward's willow (*Salix longipes* var. *Wardii*)
Black willow (*Salix nigra*)

12. Gravel bar at base of limestone slopes along Brushy Creek, sec. 8, T. 27 N., R. 3 E., six miles north of Ellsinore, Carter County.

Dominant Trees

River birch (*Betula nigra*)
Sycamore (*Platanus occidentalis*)

Dominant Shrubs

Ozark witch hazel (*Hamamelis vernalis*)
Button-bush (*Cephalanthus occidentalis*)

13. Sandy mud along Big Piney River, between Dial's Camp, east of Big Piney and Ormsby's Place at Spring Creek crossing, T. 34–35 N., R. 10–11 W., Pulaski County.

Dominant Woody Plants

Sandbar willow (*Salix interior*)
Black willow (*Salix nigra*)

Dominant Herbaceous Non-Grass Plants

Blue mist flower (*Eupatorium coelestinum*)
Cardinal flower (*Lobelia cardinalis*)
Beggar-ticks (*Bidens polylepis*)
Cocklebur (*Xanthium pensylvanicum*)
Lady's thumb (*Polygonum pensylvanicum*)

Other Herbaceous Non-Grass Plant Associates

Broad-leaved arrow-head (*Sagittaria latifolia*)
Smartweed (*Polygonum punctatum*)
Hibiscus (*Hibiscus lasiocarpos*)

Dominant Grasses

Barngrass (*Echinochloa pungens*)
Rice cut grass (*Leersia oryzoides*)

Other Grass Associates

Panic grass (*Panicum dichotomiflorum*)
Witch grass (*Panicum capillare*)
Panic grass (*Panicum Gattingeri*)

14. Alluvial woods along lower part of spring branch of Onandago Spring, Crawford County.

Dominant Trees

Silver maple (*Acer saccharinum*)
Black willow (*Salix nigra*)

Other Tree Associates

Sycamore (*Platanus occidentalis*)
River birch (*Betula nigra*)
Bur oak (*Quercus macrocarpa*)
Box elder (*Acer Negundo*)
Honey locust (*Gleditsia triacanthos*)
American elm (*Ulmus americana*)

Dominant Understory

Elder (*Sambucus canadensis*)

Dominant Herbaceous Non-Grass Plants

Wild goldenglow (*Rudbeckia laciniata*)
Aster (*Aster lateriflorus* var. *pendulus*)

15. Alluvial bottoms at Hall's Bluff, south of Davidson's Blue Spring, along Black River, sec. 4, T. 27 N., R. 4 E., four miles southeast of Mill Spring, Wayne County.

Dominant Trees

Silver maple (*Acer saccharinum*)
River birch (*Betula nigra*)
Cottonwood (*Populus deltoides*)
Green ash (*Fraxinus pensylvanica* var. *lanceolata*)
Black willow (*Salix nigra*)

Dominant Understory

Button-bush (*Cephalanthus occidentalis*)

16. Alluvial woods along lower part of spring branch of Schlicht Spring, sec. 30, T. 36 N., R. 12 W., two miles southeast of Swedeborg, Pulaski County.

Dominant Trees

Sycamore (*Platanus occidentalis*)
Black willow (*Salix nigra*)
Silver maple (*Acer saccharinum*)
American elm (*Ulmus americana*)

17. Alluvial banks along Big Piney River, between Dial's Camp, east of Big Piney and Ormsby's Place at Spring Creek crossing, T. 34–35 N., R. 10–11 W., Pulaski County.

Dominant Trees

Green ash (*Fraxinus pensylvanica* var. *lanceolata*)
Silver maple (*Acer saccharinum*)
American elm (*Ulmus americana*)

Other Tree Associates

Cottonwood (*Populus deltoides*)
Shumard's red oak (*Quercus Shumardii*)

18. Alluvial mud along Big Piney River, between Dial's Camp, east of Big Piney and Ormsby's Place at Spring Creek crossing, T. 34–35 N., R. 10–11 W., Pulaski County.

Dominant Trees

Black willow (*Salix nigra*)
Sycamore (*Platanus occidentalis*)

Dominant Herbaceous Non-Grass Plants

Three-seeded mercury (*Acalypha rhomboidea*)
Blue mist flower (*Eupatorium coelestinum*)
Horseweed (*Ambrosia trifida*)
Clearweed (*Pilea pumila* var. *Deamii*)
Spotted jewel-weed (*Impatiens biflora*)
White vervain (*Verbena urticaefolia*)
Beefsteak plant (*Perilla frutescens*)

19. Mud flat along Osage River, sec. 2, T. 40 N., R. 13 W., west of Capps, Miller County.

Lady's thumb (*Polygonum pensylvanicum*)
Small white morning glory (*Ipomoea lacunosa*)
Cocklebur (*Xanthium chinense*)
Button-weed (*Spermacoce glabra*)
Panic grass (*Panicum dichotomiflorum*)
Spurge (*Euphorbia maculata*)

(3) **Ulmus americana–Fraxinus pensylvanica** var. **lanceolata** Associes

20. Alluvial woods along Gasconade River, south of Hazel Green, Pulaski County.

Dominant Trees

Black willow (*Salix nigra*)
Silver maple (*Acer saccharinum*)
Sycamore (*Platanus occidentalis*)
Green ash (*Fraxinus pensylvanica* var. *lanceolata*)

Other Tree Associates

American elm (*Ulmus americana*)
River birch (*Betula nigra*)
Shumard's red oak (*Quercus Shumardii*)
Box elder (*Acer Negundo*)

Dominant Understory

Virginia creeper (*Parthenocissus quinquefolia*)
Winter grape (*Vitis cinerea*)
Frost grape (*Vitis cordifolia*)

Other Understory Associates

Dutchman's pipe (*Aristolochia tomentosa*)
Hispid greenbrier (*Smilax hispida*)

Dominant Herbaceous Non-Grass Plants

Blue mist flower (*Eupatorium coelestinum*)
Goldenrod (*Solidago serotina*)
Sweet William (*Phlox paniculata*)

21. Alluvial woods along Sniabar Creek, four and one-half miles south of Napoleon, Lafayette County.

Dominant Trees

Black willow (*Salix nigra*)
Green ash (*Fraxinus pensylvanica* var. *lanceolata*)
Cottonwood (*Populus deltoides*)
Silver maple (*Acer saccharinum*)
Sycamore (*Platanus occidentalis*)

Other Tree Associates

Box elder (*Acer Negundo*)
American elm (*Ulmus americana*)
Bur oak (*Quercus macrocarpa*)
Hackberry (*Celtis occidentalis*)

22. Alluvial woods along Pomme de Terre River, three miles northeast of Elkland, Hickory County.

Dominant Trees

Green ash (*Fraxinus pensylvanica* var. *lanceolata*)
Sycamore (*Platanus occidentalis*)

23. Low, alluvial woods along Noblett Creek, sec. 19, T. 26 N., R. 10 W., eight miles west of Burnham, Howell County.

Dominant Trees

Green ash (*Fraxinus pensylvanica* var. *lanceolata*)
Sycamore (*Platanus occidentalis*)
American elm (*Ulmus americana*)

Dominant Understory

Leatherwood (*Dirca palustris*)

24. Alluvial ground along King's River, south of Prentiss Ford, sec. 24, T. 21 N., R. 25 W., five miles south of Viola, in Barry County.

Dominant Trees

Green ash (*Fraxinus pensylvanica* var. *lanceolata*)
Sycamore (*Platanus occidentalis*)
River birch (*Betula nigra*)
American elm (*Ulmus americana*)
Sugar maple (*Acer saccharum* var. *glaucum*)

25. Low, alluvial woods along Gasconade River, east of Mossy Spring, sec. 2, T. 36 N., R. 11 W., seven miles northeast of Waynesville, Pulaski County.

Dominant Trees

Green ash (*Fraxinus pensylvanica* var. *lanceolata*)
American elm (*Ulmus americana*)
Silver maple (*Acer saccharinum*)

Other Tree Associates

Bur oak (*Quercus macrocarpa*)

Dominant Understory

Buck brush (*Symphoricarpos orbiculatus*)
Poison ivy (*Toxicodendron radicans*)

Other Understory Associates

Trumpet creeper (*Campsis radicans*)
(Young) Silver maple (*Acer saccharinum*)
(Young) Box elder (*Acer Negundo*)
Elderberry (*Sambucus canadensis*)
Hispid greenbrier (*Smilax hispida*)
Frost grape (*Vitis cordifolia*)
Spicebush (*Benzoin aestivale*)

Dominant Herbaceous Non-Grass Plants

Virginia knotweed (*Polygonum virginianum*)
Common blue violet (*Viola papilionacea*)
Goldenrod (*Solidago serotina*)
Blue phlox (*Phlox divaricata* var. *Laphamii*)
Ruellia (*Ruellia strepens*)
Clear weed (*Pilea pumila* var. *Deamii*)
Wild goldenglow (*Rudbeckia laciniata*)
Ironweed (*Vernonia altissima*)
Aster (*Aster lateriflorus* var. *pendulus*)
Juba bush (*Iresine rhizomatosa*)
Three-seeded mercury (*Acalypha rhomboidea*)

Other Herbaceous Non-Grass Plants

Blue mist flower (*Eupatorium coelestinum*)
Beefsteak plant (*Perilla frutescens*)
Spotted touch-me-not (*Impatiens biflora*)
Horseweed (*Ambrosia trifida*)
Water pepper (*Polygonum punctatum*)
False nettle (*Boehmeria cylindrica*)
Black nightshade (*Solanum nigrum*)

Dominant Grasses

White grass (*Leersia virginica*)
Wild rye grass (*Elymus virginicus*)
Wood reed grass (*Cinna arundinacea*)
Thin grass (*Agrostis perennans* var. *aestivalis*)

26. Alluvial woods along Current River, sec. 34, T. 25 N., R. 1 E., six miles northeast of Bennett, Ripley County.

Dominant Trees

Shumard's red oak (*Quercus Shumardii*)
American elm (*Ulmus americana*)
White ash (*Fraxinus americana*)
Cottonwood (*Populus deltoides*)
Sycamore (*Platanus occidentalis*)
Black willow (*Salix nigra*)
Silver maple (*Acer saccharinum*)

27. Alluvial banks along Black River between Mill Spring and Williamsville, sec. 15, T. 27 N., R. 4 E., Wayne County.

Dominant Trees

Cottonwood (*Populus deltoides*)
River birch (*Betula nigra*)
Silver maple (*Acer saccharinum*)
American elm (*Ulmus americana*)
Sycamore (*Platanus occidentalis*)

Other Tree Associates

Green ash (*Fraxinus pensylvanica* var. *lanceolata*)
Shumard's red oak (*Quercus Shumardii*)

Dominant Understory

Winter grape (*Vitis cinerea*)
Raccoon grape (*Ampelopsis cordata*)
Dutchman's pipe (*Aristolochia tomentosa*)

Dominant Grasses

Spike grass (*Uniola latifolia*)
Switch cane (*Arundinaria gigantea*)

28. Alluvial woods along Salt River at Asher Ford, south of Spalding, Ralls County.

Dominant Trees

Hackberry (*Celtis occidentalis* var. *canina*)
American elm (*Ulmus americana*)
Bur oak (*Quercus macrocarpa*)

Other Tree Associates

Red mulberry (*Morus rubra*)
Red haw (*Crataegus mollis*)
Honey locust (*Gleditsia triacanthos*)
Sycamore (*Platanus occidentalis*)

Dominant Understory

Elderberry (*Sambucus canadensis*)
Bristly greenbrier (*Smilax hispida*)

Dominant Herbaceous Non-Grass Plants

Aster (*Aster lateriflorus* var. *pendulus*)
Climbing buckwheat (*Polygonum scandens*)
One-seeded bur cucumber (*Sicyos angulatus*)
Pale-flowered touch-me-not (*Impatiens pallida*)
Three-seeded mercury (*Acalypha rhomboidea*)
Goldenrod (*Solidago serotina*)
Clearweed (*Pilea pumila* var. *Deamii*)
Horseweed (*Ambrosia trifida*)
Actinomeris (*Actinomeris alternifolia*)
Slender nettle (*Urtica procera*)

Dominant Grasses

Wild rye (*Elymus canadensis*)
White grass (*Leersia virginica*)

29. Alluvial woods along Hazel Creek, sec. 14, T. 36 N., R. 1 W., one mile southwest of Palmer, Washington County.

Dominant Trees

Sycamore (*Platanus occidentalis*)
American elm (*Ulmus americana*)
Honey locust (*Gleditsia triacanthos* var. *inermis*)
Bur oak (*Quercus macrocarpa*)
Black cherry (*Prunus serotina*)
White ash (*Fraxinus americana*)
Chinquapin oak (*Quercus Muhlenbergii*)
Shingle oak (*Quercus imbricaria*)

Dominant Understory

Smooth alder (*Alnus rugosa*)
Ward's willow (*Salix longipes* var. *Wardii*)
Redbud (*Cercis canadensis*)
Button-bush (*Cephalanthus occidentalis*)
Ironwood (*Carpinus caroliniana*)

30. Alluvial woods along spring branch of Montauk Spring in Montauk State Park, near Montauk, Dent County.

Dominant Trees

River birch (*Betula nigra*)
Black walnut (*Juglans nigra*)
Shingle oak (*Quercus imbricaria*)
American elm (*Ulmus americana*)
Black willow (*Salix nigra*)

Dominant Understory

Chittim-wood (*Bumelia lanuginosa*)
Black haw (*Viburnum rufidulum*)
Smooth alder (*Alnus rugosa*)

31. Alluvial, lime-bouldered banks along White River between Forsyth and Moore's Ferry, Taney County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Green ash (*Fraxinus pensylvanica* var. *lanceolata*)
American elm (*Ulmus americana*)

Other Tree Associates

Hackberry (*Celtis occidentalis*)
Bur oak (*Quercus macrocarpa*)
River birch (*Betula nigra*)
Shumard's red oak (*Quercus Shumardii*)
Catalpa (*Catalpa speciosa*)

Dominant Understory

Ironwood (*Carpinus caroliniana*)
Swamp privet (*Forestiera acuminata*)

32. Alluvial woods at Hall's Bluff, south of Davidson's Blue Spring along Black River, sec. 4, T. 27 N., R. 4 E., four miles southeast of Mill Spring, Wayne County.

Dominant Trees

Box elder (*Acer Negundo*)
Hackberry (*Celtis occidentalis*)
American elm (*Ulmus americana*)
Sweet gum (*Liquidambar Styraciflua*)

(4) **Acer saccharum–Carya cordiformis** Associes

33. Alluvial woods along Eleven Points River, sec. 18, T. 24 N., R. 2 W., three and one-half miles south of Wilderness, Oregon County.

Dominant Trees

American elm (*Ulmus americana*)
Sycamore (*Platanus occidentalis*)

Other Tree Associates

Shumard's red oak (*Quercus Shumardii*)
Chinquapin oak (*Quercus Muhlenbergii*)
Bur oak (*Quercus macrocarpa*)
Black willow (*Salix nigra*)
Linden (*Tilia glabra*)
River birch (*Betula nigra*)
Bitternut hickory (*Carya cordiformis*)
Northern red oak (*Quercus borealis* var. *maxima*)
Pignut hickory (*Carya ovalis* var. *obovalis*
Persimmon (*Diospyros virginiana*)

Dominant Understory

Pawpaw (*Asimina triloba*)

Other Understory Associates

Button-bush (*Cephalanthus occidentalis*)
Ironwood (*Carpinus caroliniana*)
Hop tree (*Ptelea trifoliata*)
Chittim-wood (*Bumelia lanuginosa*)

34. Alluvial woods at base of west-facing limestone slopes along Otter Creek, sec. 18, T. 27 N., R. 6 E., near Taskee, Wayne County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Sycamore (*Platanus occidentalis*)
Bitternut hickory (*Carya cordiformis*)
Winged elm (*Ulmus alata*)
American elm (*Ulmus americana*)
Box elder (*Acer Negundo*)
River birch (*Betula nigra*)

Dominant Understory

Button-bush (*Cephalanthus occidentalis*)
Hop hornbeam (*Ostrya virginiana*)
Alder (*Alnus rugosa*)
Mulberry (*Morus rubra*)
Black haw (*Viburnum rufidulum*)
Red-flowered buckeye (*Aesculus discolor* var. *mollis*)
Spicebush (*Benzoin aestivale*)
Persimmon (*Diospyros virginiana*)
Hazelnut (*Corylus americana*)

This is not an alluvial flora as developed on large streams or flood plains, but is partly alluvial and partly some of the flora of the adjacent lower slopes.

35. Alluvial woods along Huzzah Creek, two miles southeast of Davisville, Crawford County.

Dominant Tree

Sugar maple (*Acer saccharum* var. *glaucum*)

Other Tree Associates

American elm (*Ulmus americana*)
Green ash (*Fraxinus pensylvanica* var. *lanceolata*)
Sycamore (*Platanus occidentalis*)
Bur oak (*Quercus macrocarpa*)
Butternut (*Juglans cinerea*)
Blue ash (*Fraxinus quadrangulata*)
Honey locust (*Gleditsia triacanthos*)
Big shell-bark hickory (*Carya laciniosa*)

Dominant Understory

Ironwood (*Carpinus caroliniana*)
Pawpaw (*Asimina triloba*)

Other Understory Associates

Ohio buckeye (*Aesculus glabra* f. *pallida*)
Raccoon grape (*Ampelopsis cordata*)

Dominant Herbaceous Non-Grass Plants

Beggar's lice (*Lappula virginiana*)
Beefsteak plant (*Perilla frutescens*)
Three-seeded mercury (*Acalypha rhomboidea*)

36. Rich woods built up on alluvial formation at the base of Hall's Bluff, south of Davidson's Blue Spring along Black River, sec. 4, T. 27 N., R. 4 E., four miles southeast of Mill Spring, Wayne County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Kentucky coffee tree (*Gymnocladus dioica*)
Walnut (*Juglans nigra*)
Butternut (*Juglans cinerea*)
Mulberry (*Morus rubra*)
Chinquapin oak (*Quercus Muhlenbergii*)
Northern red oak (*Quercus borealis* var. *maxima*)
Persimmon (*Diospyros virginiana*)
Hackberry (*Celtis laevigata*)

Dominant Understory

Spicebush (*Benzoin aestivale*)
American hornbeam (*Carpinus caroliniana*)
American bladdernut (*Staphylea trifolia*)
Pawpaw (*Asimina triloba*)
Flowering dogwood (*Cornus florida*)
Hazelnut (*Corylus americana*)
Greenbrier (*Smilax hispida*)

Dominant Herbaceous Non-Grass Plants

Honewort (*Cryptotaenia canadensis*)
Blue phlox (*Phlox divaricata* var. *Laphamii*)
Virginia knotweed (*Polygonum virginianum*)
Virginia tickseed (*Lappula virginiana*)
Bloodroot (*Sanguinaria canadensis*)
Maidenhair fern (*Adiantum pedatum*)
Jack-in-the-pulpit (*Arisaema triphyllum*)

Dominant Grass

Fescue grass (*Festuca obtusa*)

37. Rich, alluvial bottom woods along Cane Creek, sec. 17, T. 26 N., R. 4 E., six miles southwest of Williamsville, Wayne County.

Dominant Trees

Bitternut hickory (*Carya cordiformis*)
White oak (*Quercus alba*)
Northern red oak (*Quercus borealis* var. *maxima*)
Shingle oak (*Quercus imbricaria*)
American ash (*Fraxinus americana*)
Walnut (*Juglans nigra*)
Mulberry (*Morus rubra*)
American elm (*Ulmus americana*)
Sweet gum (*Liquidambar Styraciflua*)
River birch (*Betula nigra*)
Honey locust (*Gleditsia triacanthos*)
Silver maple (*Acer saccharinum*)
Cottonwood (*Populus deltoides*)
Sycamore (*Platanus occidentalis*)

Dominant Understory

American hornbeam (*Carpinus caroliniana*)
Flowering dogwood (*Cornus florida*)
Redbud (*Cercis canadensis*)
Black haw (*Viburnum rufidulum*)
Red-flowering buckeye (*Aesculus discolor* var. *mollis*)
Buck brush (*Symphoricarpos orbiculatus*)
Hazelnut (*Corylus americana*)
Pawpaw (*Asimina triloba*)
Alder (*Alnus rugosa*)
Elderberry (*Sambucus canadensis*)

Dominant Grasses

Spike grass (*Uniola latifolia*)
Wood reed grass (*Cinna arundinacea*)
Fowl meadow grass (*Glyceria striata*)

38. Along Ten Mile Creek, loaded with chert from adjacent slopes, sec. 9, T. 25 N., R. 4 E., 13 miles northwest of Poplar Bluff, Butler County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
White oak (*Quercus alba*)
Shingle oak (*Quercus imbricaria*)
River birch (*Betula nigra*)
Mockernut hickory (*Carya tomentosa*)
Red maple (*Acer rubrum*)
Silver maple (*Acer saccharinum*)
White ash (*Fraxinus americana*)
Sweet gum (*Liquidambar Styraciflua*)
Winged elm (*Ulmus alata*)

Dominant Understory

Ozark witch hazel (*Hamamelis vernalis*)
Ward's willow (*Salix longipes* var. *Wardii*)
Smooth alder (*Alnus rugosa*)
Button-bush (*Cephalanthus occidentalis*)

Other Understory Associates

Persimmon (*Diospyros virginiana*)
Black haw (*Viburnum prunifolium*)
Black haw (*Viburnum rufidulum*)
Buck brush (*Symphoricarpos orbiculatus*)
Dogwood (*Cornus florida*)
Dwarf sumac (*Rhus Copallina*)
Smooth sumac (*Rhus glabra*)
Deerberry (*Vaccinium stamineum* var. *neglectum*)
Chittim-wood (*Bumelia lanuginosa*)
Red-flowered buckeye (*Aesculus discolor* var. *mollis*)
Ironwood (*Carpinus caroliniana*)
Shadbush, serviceberry (*Amelanchier canadensis*)
Ninebark (*Physocarpus opulifolius* var. *intermedius*)
Hop tree (*Ptelea trifoliata*)

Dominant Herbaceous Non-Grass Plants

Rough button-weed (*Diodia teres* var. *setigera*)
Water willow (*Dianthera americana*)

39. Rich, low woods along Big Barren Creek, near "Blue Spring," sec. 4, T. 25 N., R. 1 W., two and one-half miles southwest of Eastwood, 10 miles northwest of Bennett, Carter County.

Dominant Trees

Linden (*Tilia glabra*)
Bitternut hickory (*Carya cordiformis*)
White ash (*Fraxinus americana*)
American elm (*Ulmus americana*)
Butternut (*Juglans cinerea*)
White oak (*Quercus alba*)
Chinquapin oak (*Quercus Muhlenbergii*)
Northern red oak (*Quercus borealis* var. *maxima*)
Sycamore (*Platanus occidentalis*)
Winged elm (*Ulmus alata*)
Sour gum (*Nyssa sylvatica* var. *caroniana*)

Dominant Understory

Ironwood (*Carpinus caroliniana*)
Spicebush (*Benzoin aestivale*)
Hazelnut (*Corylus americana*)
Black haw (*Viburnum rufidulum*)
Fragrant sumac (*Rhus aromatica*)
Buck brush (*Symphoricarpos orbiculatus*)
Redbud (*Cercis canadensis*)

40. Alluvial woods along Eleven Points River opposite west-facing slopes, sec. 11, T. 24 N., R. 3 W., one mile southeast of Turner's Mill, four miles southwest of Wilderness, Oregon County.

Dominant Trees

American elm (*Ulmus americana*)
Sycamore (*Platanus occidentalis*)

Other Tree Associates

Shumard's red oak (*Quercus Shumardii*)
Bur oak (*Quercus macrocarpa*)
Black willow (*Salix nigra*)
River birch (*Betula nigra*)
Northern red oak (*Quercus borealis* var. *maxima*)
Chinquapin oak (*Quercus Muhlenbergii*)
Persimmon (*Diospyros virginiana*)
Linden (*Tilia glabra*)
Butternut (*Juglans cinerea*)
Bitternut hickory (*Carya cordiformis*)
Pignut hickory (*Carya ovalis* var. *obovalis*)

Dominant Understory

Pawpaw (*Asimina triloba*)

Other Understory Associates

Button-bush (*Cephalanthus occidentalis*)
Hop tree (*Ptelea trifoliata*)
Chittim-wood (*Bumelia lanuginosa*)
Ironwood (*Carpinus caroliniana*)
Dogwood (*Cornus florida*)

41. Low, alluvial woods around Iron Mountain Lake, five miles south of Bismarck, St. Francois County.

Dominant Trees

Black willow (*Salix nigra*)
Swamp white oak (*Quercus bicolor*)
Shingle oak (*Quercus imbricaria*)
White oak (*Quercus alba*)
Northern red oak (*Quercus borealis* var. *maxima*)
Red maple (*Acer rubrum*)
American elm (*Ulmus americana*)
Bitternut hickory (*Carya cordiformis*)
Shagbark hickory (*Carya ovata*)
White ash (*Fraxinus americana*)
Sycamore (*Platanus occidentalis*)
Black walnut (*Juglans nigra*)
Sugar maple (*Acer saccharum* var. *glaucum*)

Dominant Shrubs

Hazelnut (*Corylus americana*)
Bristly greenbrier (*Smilax hispida*)
Smooth alder (*Alnus rugosa*)

42. Wooded valley floor along Brazil Creek, sec. 28, T. 38 N., R. 1 W., six miles northeast of Berryman, Washington County.

Dominant Trees

White oak (*Quercus alba*)
Sugar maple (*Acer saccharum* var. *glaucum*)
Sycamore (*Platanus occidentalis*)
Bitternut hickory (*Carya cordiformis*)

Dominant Understory

Flowering dogwood (*Cornus florida*)
Hop hornbeam (*Ostrya virginiana*)

43. Alluvial woods along Bee Fork of Black River, sec. 23, T. 32 N., R. 1 W., four miles northwest of Centerville, Reynolds County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Butternut (*Juglans cinerea*)
Chinquapin oak (*Quercus Muhlenbergii*)
Black walnut (*Juglans nigra*)
Sycamore (*Platanus occidentalis*)
American elm (*Ulmus americana*)

Dominant Understory

Ironwood (*Carpinus caroliniana*)
Pawpaw (*Asimina triloba*)
Leatherwood (*Dirca palustris*)
Elderberry (*Sambucus canadensis*)
Buck brush (*Symphoricarpos orbiculatus*)
Flowering dogwood (*Cornus florida*)
Frost grape (*Vitis cordifolia*)

44. Alluvial woods along Brushy Creek, sec. 24, T. 32 N., R. 1 W., one mile north of Moses Store, Reynolds County.

Dominant Trees

Shumard's red oak (*Quercus Shumardii*)
American elm (*Ulmus americana*)
Sycamore (*Platanus occidentalis*)
Butternut (*Juglans cinerea*)
Bitternut hickory (*Carya cordiformis*)
Sugar maple (*Acer saccharum* var. *glaucum*)

Dominant Understory

Pawpaw (*Asimina triloba*)
Spicebush (*Benzoin aestivale*)
Moonseed (*Menispermum canadense*)
Buck brush (*Symphoricarpos orbiculatus*)

45. Alluvial woods along Big Piney River, nine miles west of Licking, Texas County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Sycamore (*Platanus occidentalis*)
River birch (*Betula nigra*)
American elm (*Ulmus americana*)
White ash (*Fraxinus americana*)
Black gum (*Nyssa sylvatica* var. *caroliniana*)
Sassafras (*Sassafras albidum* var. *molle*)
Hackberry (*Celtis occidentalis* var. *canina*)
Black walnut (*Juglans nigra*)
White oak (*Quercus alba*)
Bur oak (*Quercus macrocarpa*)
Shumard's red oak (*Quercus Shumardii*)
Chinquapin oak (*Quercus Muhlenbergii*)

Dominant Understory

Ohio buckeye (*Aesculus glabra* f. *pallida*)

46. Alluvial woods along Big Creek, sec. 22, T. 31 N., R. 3 W., one and one-half miles west of Rat, Shannon County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Shumard's red oak (*Quercus Shumardii*)
Sycamore (*Platanus occidentalis*)

Other Tree Associates

Bitternut hickory (*Carya cordiformis*)
Chinquapin oak (*Quercus Muhlenbergii*)

Dominant Understory

Leatherwood (*Dirca palustris*)
Ironwood (*Carpinus caroliniana*)
Pawpaw (*Asimina triloba*)

Other Understory Associates

Buck brush (*Symphoricarpos orbiculatus*)
Flowering dogwood (*Cornus florida*)

Dominant Herbaceous Non-Grass Plant

Beefsteak plant (*Perilla frutescens*)

II. ACER SACCHARUM–QUERCUS ALBA ASSOCIATION

(2) Juniperus virginiana–Rhus trilobata var. serotina Associes

47. Upland limestone glade of bald knob in Hercules Game Refuge, sec. 10–11, T. 24 N., R. 18 W., two miles southwest of Hercules, Taney County.

Dominant Tree

Smoke-tree (*Cotinus americanus*)

Other Tree Associates

Persimmon (*Diospyros virginiana*) Red cedar (*Juniperus virginiana*)

Dominant Understory

Fragrant sumac (*Rhus trilobata* var. *serotina*) Greenbrier (*Smilax Bona-nox*)

Understory Associate

Buck brush (*Symphoricarpos orbiculatus*)

Dominant Herbaceous Non-Grass Plants

Prairie clover (*Petalostemum purpureum*) *Heliotropium tenellum*
Stinging nettle (*Tragia urticaefolia*) Sandwort (*Arenaria patula*)
Hogwort (*Croton capitatus*) *Palafoxia callosa*
Linum sulcatum

Dominant Grasses

Side-oats grama (*Bouteloua curtipendula*) Big blue-stem (*Andropogon provincialis*)

48. Limestone bald knobs around Swan U. S. Lookout Tower, sec. 20, T. 25 N., R. 18 W., four miles east of Garrison, Christian County.

Dominant Trees

Persimmon (*Diospyros virginiana*) Winged elm (*Ulmus alata*)
Red cedar (*Juniperus virginiana*)

Dominant Understory

Supple-jack (*Berchemia scandens*)

Dominant Herbaceous Non-Grass Plants

Calamint (*Satureja glabella* var. *angustifolia*)

Other Herbaceous Non-Grass Plant Associates

Blue false indigo (*Baptisia minor*) Black-eyed Susan (*Rudbeckia missouriensis*)
Feverfew (*Parthenium hispidum*)

Dominant Grass

Side-oats grama (*Bouteloua curtipendula*)

49. Limestone slopes in small ravine between upper exposed parts of bald knobs in Hercules Game Refuge, sec. 10–11, T. 24 N., R. 18 W., two miles southwest of Hercules, Taney County.

Dominant Trees

Schneck's red oak (*Quercus Shumardii* var. *Schneckii*) Smoke tree (*Cotinus americanus*)
Chinquapin oak (*Quercus Muhlenbergii*)

Other Tree Associates

Redbud (*Cercis canadensis*) Fringe tree (*Chionanthus virginica*)

Dominant Understory

Fragrant sumac, pole-cat bush (*Rhus trilobata* var. *serotina*)

(4) **Ulmus alata–Rhamnus caroliniana** Associes

50. Low woods along branch in Stilwell Hollow, Low Gap Game Refuge, southeast of Black U. S. Lookout, sec. 12, T. 32 N., R. 1 E., four miles southwest of Black, Reynolds County.

Dominant Trees

Winged elm (*Ulmus alata*)
Bitternut hickory (*Carya cordiformis*)
White ash (*Fraxinus americana*)
Chinquapin oak (*Quercus Muhlenbergii*)

Dominant Understory

Pawpaw (*Asimina triloba*)
Buck brush (*Symphoricarpos orbiculatus*)
Redbud (*Cercis canadensis*)

Dominant Herbaceous Non-Grass Plant

Beefsteak plant (*Perilla frutescens*)

(5) **Quercus Muhlenbergii–Fraxinus americana** Associes

51. Limestone glades and ledges on bluffs along East Fork of Bull Creek, sec. 26, T. 26 N., R. 20 W., three miles southwest of Chadwick, Christian County.

Dominant Trees

Schneck's red oak (*Quercus Schumardii* var. *Schneckii*)
Chinquapin oak (*Quercus Muhlenbergii*)

Dominant Shrubs

Chittim-wood (*Bumelia lanuginosa*)
Black haw (*Viburnum rufidulum*)
Winged elm (*Ulmus alata*)

Other Shrub Associates

Redbud (*Cercis canadensis*)
Indian cherry (*Rhamnus caroliniana*)
Fragrant sumac (*Rhus trilobata* var. *serotina*)
Persimmon (*Diospyros virginiana*)
Rough-leaved dogwood (*Cornus asperifolia*)

Dominant Herbaceous Non-Grass Plants

Black-eyed Susan (*Rudbeckia missouriensis*)
Houstonia nigricans

Other Herbaceous Non-Grass Plant Associates

Wine-cups (*Callirhoe digitata*)
Gum-plant (*Grindelia lanceolata*)

Dominant Grasses

Blue-stem (*Andropogon scoparius* var. *genuinus*)
Side-oats grama (*Bouteloua curtipendula*)
Big blue-stem (*Andropogon provincialis*)

52. Limestone bluffs along Hazel Creek, sec. 14, T. 36 N., R. 1 W., one mile southwest of Palmer, Washington County.

Dominant Trees

Slippery elm (*Ulmus fulva*)
Chinquapin oak (*Quercus Muhlenbergii*)
White ash (*Fraxinus americana*)

Dominant Understory

Rough-leaved dogwood (*Cornus asperifolia*)
Swamp dogwood (*Cornus obliqua*)
Black haw (*Viburnum rufidulum*)

53. Northwest-facing slopes along Marble Creek, sec. 20, T. 32 N., R. 5 E., two miles southwest of French Mills, Madison County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Northern red oak (*Quercus borealis* var. *maxima*)
Chinquapin oak (*Quercus Muhlenbergii*)

Other Tree Associates

White ash (*Fraxinus americana*)
Butternut (*Juglans cinerea*)
Kentucky coffee tree (*Gleditsia triacanthos*)
Linden (*Tilia glabra*)
American elm (*Ulmus americana*)
Blue ash (*Fraxinus quadrangulata*)
Slippery elm (*Ulmus fulva*)

Dominant Understory

Indian cherry (*Rhamnus caroliniana*)
Ninebark (*Physocarpus opulifolius* var. *intermedius*)
Black haw (*Viburnum rufidulum*)
Hop hornbeam (*Ostrya virginiana*)
Red cedar (*Juniperus virginiana*)

54. Lower, west-facing, limestone slopes along Eleven Points River, sec. 11, T. 24 N., R. 3 W., one mile southeast of Turner's Mill, four miles southwest of Wilderness, Oregon County.

Dominant Trees

Chinquapin oak (*Quercus Muhlenbergii*)
White ash (*Fraxinus americana*)
Redbud (*Cercis canadensis*)
Butternut (*Juglans cinerea*)
Linden (*Tilia glabra*)
Sugar maple (*Acer saccharum*)
Hackberry (*Celtis occidentalis*)
American elm (*Ulmus americana*)
Blue ash (*Fraxinus quadrangulata*)
Shumard's red oak (*Quercus Shumardii*)
Box elder (*Acer Negundo*)

Dominant Understory

Buck brush (*Symphoricarpos orbiculatus*)
Pawpaw (*Asimina triloba*)
Ironwood (*Carpinus caroliniana*)
Spicebush (*Benzoin aestivale*)
Red mulberry (*Morus rubra*)
American bladdernut (*Staphylea trifolia*)
Black haw (*Viburnum rufidulum*)
Rough-leaved dogwood (*Cornus asperifolia*

55. West-facing, wooded, limestone slopes along Castor River, at Hahn's Mill, sec. 16, T. 33 N., R. 8 E., four miles northeast of Cornwall, Madison County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Northern red oak (*Quercus borealis* var. *maxima*)
White oak (*Quercus alba*)

Other Tree Associates

Red maple (*Acer rubrum*)
White ash (*Fraxinus americana*)
Shagbark hickory (*Carya ovata*)
Linden (*Tilia glabra*)
Chinquapin oak (*Quercus Muhlenbergii*)

Dominant Understory

Ironwood (*Carpinus caroliniana*)

Other Understory Associates

Black haw (*Viburnum rufidulum*)
Flowering dogwood (*Cornus florida*)
Smooth alder (*Alnus rugosa*)
Hop hornbeam (*Ostrya virginiana*)
Bladdernut (*Staphylea trifolia*)

56. North-facing, wooded, limestone slopes along Brazil Creek, sec. 28, T. 38 N., R. 1 W., six miles northeast of Berryman, Washington County.

UPPER PORTION OF SLOPES

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Northern red oak (*Quercus borealis* var. *maxima*)
Schneck's red oak (*Quercus Shumardii* var. *Schneckii*)
Chinquapin oak (*Quercus Muhlenbergii*)

LOWER PORTION OF SLOPES

Dominant Trees

Linden (*Tilia glabra*)
Sugar maple (*Acer saccharum* var. *glaucum*)
Chinquapin oak (*Quercus Muhlenbergii*)
American elm (*Ulmus americana*)

Dominant Understory

Chittim-wood (*Bumelia lanuginosa*)
Black haw (*Viburnum rufidulum*)
Indian cherry (*Rhamnus caroliniana* var. *mollis*)
Redbud (*Cercis canadensis*)
Ironwood (*Carpinus caroliniana*)
Bladdernut (*Staphylea trifolia*)
Hackberry (*Celtis pumila* var. *georgiana*)

57. One-half to two-thirds the way up south-facing limestone slopes along Bee Fork of Black River, sec. 29, T. 32 N., R. 1 W., seven miles west of Centerville, Reynolds County.

Dominant Tree

Chinquapin oak (*Quercus Muhlenbergii*)

Tree Associate

Shagbark hickory (*Carya ovata*)

Dominant Understory

Flowering dogwood (*Cornus florida*)
Black haw (*Viburnum rufidulum*)

Other Understory Associates

Hop hornbeam (*Ostrya virginiana*)
Greenbrier (*Smilax Bona-nox*)
Chittim-wood (*Bumelia lanuginosa*)

58. Two-thirds to three-fourths the way up south-facing limestone slopes along Bee Fork of Black River, sec. 29, T. 32 N., R. 1 W., seven miles west of Centerville, Reynolds County.

Dominant Trees

Schneck's red oak (*Quercus Shumardii* var. *Schneckii*)
White oak (*Quercus alba*)

Other Tree Associates

Post oak (*Quercus stellata*)
Shingle oak (*Quercus imbricaria*)
Slippery elm (*Ulmus fulva*)
Persimmon (*Diospyros virginiana*)

Dominant Understory

Dwarf hackberry (*Celtis pumila* var. *georgiana*)
Wild plum (*Prunus americana*)

59. Base of limestone slopes along Eleven Points River, sec. 11, T. 24 N., R. 3 W., one mile southeast of Turner's Mill, four miles southwest of Wilderness, Oregon County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
Chinquapin oak (*Quercus Muhlenbergii*)
Linden (*Tilia glabra*)
American elm (*Ulmus americana*)
White ash (*Fraxinus americana*)
Black walnut (*Juglans nigra*)

Tree Associate

Persimmon (*Diospyros virginiana*)

Dominant Understory

American bladdernut (*Staphylea trifolia*)
Pawpaw (*Asimina triloba*)
Redbud (*Cercis canadensis*)

Other Understory Associates

Ironwood (*Carpinus caroliniana*)
Spicebush (*Benzoin aestivale*)
Hazelnut (*Corylus americana*)
Black haw (*Viburnum rufidulum*)

60. West-facing limestone slopes along Current River, sec. 34, T. 25 N., R. 1 E., five miles northeast of Bennett, Ripley County.

Dominant Trees

Sugar maple (*Acer saccharum*)
Sweet gum (*Liquidambar Styraciflua*)
Linden (*Tilia glabra*)
Chinquapin oak (*Quercus Muhlenbergii*)
Persimmon (*Diospyros virginiana*)
White ash (*Fraxinus americana*)
Red cedar (*Juniperus virginiana*)

Dominant Understory

Black haw (*Viburnum rufidulum*)
Redbud (*Cercis canadensis*)
Possum haw (*Ilex decidua*)
Hop hornbeam (*Ostrya virginiana*)
Rough-leaved dogwood (*Cornus asperifolia*)
Ninebark (*Physocarpus opulifolius* var. *intermedius*)
Ironwood (*Carpinus caroliniana*)
Indian cherry (*Rhamnus caroliniana*)
Sassafras (*Sassafras albidum* var. *molle*)

Dominant Herbaceous Non-Grass Plants

Dutchman's pipe (*Aristolochia tomentosa*)
Rattle weed (*Astragalus canadensis*)

Dominant Grass

Switch cane (*Arundinaria gigantea*)

61. Wooded limestone bluffs along Beaver Creek, sec. 21 and 22, T. 24 N., R. 18 W., three miles southwest of Bradleyville, Taney County.

Dominant Trees

Chinquapin oak (*Quercus Muhlenbergii*)
Smoke tree (*Cotinus americanus*)

Other Tree Associates

Sugar maple (*Acer saccharum* var. *glaucum*)
Butternut (*Juglans cinerea*)
American elm (*Ulmus americana*)
Hackberry (*Celtis occidentalis* var. *canina*)
Linden (*Tilia glabra*)

Dominant Understory

Spicebush (*Benzoin aestivale*)

Understory Associate

Persimmon (*Diospyros virginiana*)

62. Limestone glade on bluffs along Eleven Points River, sec. 11, T. 24 N., R. 3 W., one mile southeast of Turner's Mill, four miles southwest of Wilderness, Oregon County.

Dominant Trees

Chinquapin oak (*Quercus Muhlenbergii*)
Hackberry (*Celtis laevigata* var. *texana*)

Dominant Understory

Winged elm (*Ulmus alata*)
Hop hornbeam (*Ostrya virginiana*)
Black haw (*Viburnum rufidulum*)
Buck brush (*Symphoricarpos orbiculatus*)
Chittim-wood (*Bumelia lanuginosa*)
Fragrant sumac (*Rhus aromatica*)
Shadbush (*Amelanchier canadensis*)
Greenbrier (*Smilax Bona-nox*)

63. West-facing limestone slopes along Middle Fork of Black River, sec. 20, T. 34 N., R. 1 E., one mile north of Redmondville, Iron County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Chinquapin oak (*Quercus Muhlenbergii*)
Slippery elm (*Ulmus fulva*)

Other Tree Associates

Schneck's red oak (*Quercus Shumardii* var. *Schneckii*)
Red cedar (*Juniperus virginiana*)
White ash (*Fraxinus americana*)

Dominant Understory

Chittim-wood (*Bumelia lanuginosa*)
Hop hornbeam (*Ostrya virginiana*)
Black haw (*Viburnum rufidulum*)

Dominant Grasses

Wild chess (*Bromus purgans*)
Sphenopholis (*Sphenopholis intermedia*)

(6) **Acer saccharum–Quercus alba** Associes

64. At base of south-facing limestone slopes along Bee Fork of Black River, sec. 29, T. 32 N., R. 1 W., seven miles west of Centerville, Reynolds County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
White oak (*Quercus alba*)
Northern red oak (*Quercus borealis* var. *maxima*)
Slippery elm (*Ulmus fulva*)
Winged elm (*Ulmus alata*)
Sassafras (*Sassafras albidum* var. *molle*)
Red mulberry (*Morus rubra*)
Bitternut hickory (*Carya cordiformis*)

Tree Associate

Persimmon (*Diospyros virginiana*)

Dominant Understory

Black haw (*Viburnum rufidulum*)
Redbud (*Cercis canadensis*)

Other Understory Associates

Fragrant sumac (*Rhus aromatica*)
Greenbrier (*Smilax Bona-nox*)
Frost grape (*Vitis cordifolia*)
Ironwood (*Carpinus caroliniana*)
Smooth sumac (*Rhus glabra*)

65. Northeast-facing, limestone, wooded slopes along Black River, north of Markham Spring, sec. 23, T. 27 N., R. 4 E., three miles west of Williamsville, Wayne County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Chinquapin oak (*Quercus Muhlenbergii*)
Northern red oak (*Quercus borealis* var. *maxima*)
Butternut (*Juglans cinerea*)
American elm (*Ulmus americana*)
White ash (*Fraxinus americana*)
Sweet gum (*Liquidambar Styraciflua*)
Sycamore (*Platanus occidentalis*)
Bitternut hickory (*Carya cordiformis*)
Linden (*Tilia glabra*)

Dominant Understory

Ironwood (*Carpinus caroliniana*)
Rough-leaved dogwood (*Cornus asperifolia*)
Spicebush (*Benzoin aestivale*)
American bladdernut (*Staphylea trifolia*)
Hydrangea (*Hydrangea arborescens*)
Flowering dogwood (*Cornus florida*)
Bristly greenbrier (*Smilax hispida*)
Frost grape (*Vitis cordifolia*)
Button-bush (*Cephalanthus occidentalis*)
Black haw (*Viburnum rufidulum*)
Burning bush (*Euonymus atropurpureus*)
Hop hornbeam (*Ostrya virginiana*)
Poison ivy (*Toxicodendron radicans*)
Smooth alder (*Alnus rugosa*)

Dominant Herbaceous Non-Grass Plant

Liverleaf (*Hepatica acutiloba*)

Dominant Grasses

Fescue grass (*Festuca obtusa*)
Switch cane (*Arundinaria gigantea*)

66. Along south-facing limestone bluffs of King's River, one mile southwest of Prentiss Ford, sec. 19–24, T. 21 N., R. 25 W., five miles south of Viola, Barry County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Chinquapin oak (*Quercus Muhlenbergii*)

Other Tree Associates

Yellow-wood (*Cladrastis lutea*)
American elm (*Ulmus americana*)
Red mulberry (*Morus rubra*)
Black walnut (*Juglans nigra*)

Dominant Understory

Redbud (*Cercis canadensis*)
Hackberry (*Celtis occidentalis*)

Other Understory Associates

Indian cherry (*Rhamnus caroliniana* var. *mollis*)
Red cedar (*Juniperus virginiana*)
Pawpaw (*Asimina triloba*)
Spicebush (*Benzoin aestivale*)
Black haw (*Viburnum rufidulum*)
Buck brush (*Symphoricarpos orbiculatus*)

Dominant Herbaceous Non-Grass Plants

White snakeroot (*Eupatorium urticaefolium*)
Black snakeroot (*Sanicula canadensis*)
Thimble weed (*Anemone virginiana*)
Beggar's ticks (*Desmodium acuminatum*)

Other Herbaceous Non-Grass Plants

Frost grape (*Vitis cordifolia*)
Yellow violet (*Viola eriocarpa*)
Lopseed (*Phryma Leptostachya*)
American bellflower (*Campanula americana*)
Wild licorice (*Galium circaezans* var. *hypomalacum*)
Virginia knotweed (*Polygonum virginianum*)
Solomon's seal (*Polygonatum canaliculatum*)
Virgin's bower (*Clematis virginiana* var. *missouriensis*)
Leather flower (*Clematis versicolor*)
Skull-cap (*Scutellaria ovata*)
Skull-cap (*Scutellaria ovalifolia*)
Bear grass (*Yucca arkansana*)

Dominant Grasses

Spike grass (*Uniola latifolia*)
Wild chess (*Bromus purgans*)

67. East-facing limestone bluffs along Huzzah Creek, two miles southeast of Davisville, Crawford County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
Chinquapin oak (*Quercus Muhlenbergii*)

Other Tree Associates

Sugar maple (*Acer saccharum* var. *glaucum*)
Linden (*Tilia glabra*)
White ash (*Fraxinus americana*)
Black walnut (*Juglans nigra*)
Bitternut hickory (*Carya cordiformis*)
American elm (*Ulmus americana*)
Blue ash (*Fraxinus quadrangulata*)
Red mulberry (*Morus rubra*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Shagbark hickory (*Carya ovata*)

Dominant Understory

Bladdernut (*Staphylea trifolia*)

Other Understory Associates

Spicebush (*Benzoin aestivale*)
Sassafras (*Sassafras albidum* var. *molle*)
Burning bush (*Euonymus atropurpureus*)
Flowering dogwood (*Cornus florida*)
Persimmon (*Diospyros virginiana*)
Black haw (*Viburnum rufidulum*)
Pawpaw (*Asimina triloba*)
Redbud (*Cercis canadensis*)
Rough-leaved dogwood (*Cornus asperifolia*)

Dominant Herbaceous Non-Grass Plants

Bristly greenbrier (*Smilax hispida*)
Maidenhair fern (*Adiantum pedatum*)
Wild yam (*Dioscorea quaternata*)
Leafcup (*Polymnia canadensis*)

68. Wooded talus at base of east-facing limestone bluff, "Log-slide Bluff," along White River, sec. 22–27, T. 22 N., R. 23 W., two miles west of Marmaros, Stone County.

Dominant Trees

Linden (*Tilia glabra*)
Sugar maple (*Acer saccharum* var. *glaucum*)
Bitternut hickory (*Carya cordiformis*)
Northern red oak (*Quercus borealis* var. *maxima*)

Other Tree Associates

Butternut (*Juglans cinerea*)
Hackberry (*Celtis occidentalis* var. *canina*)
Chinquapin oak (*Quercus Muhlenbergii*)
Yellow-wood (*Cladrastis lutea*)

Dominant Understory

Bladdernut (*Staphylea trifolia*)
Ironwood (*Carpinus caroliniana*)
Pawpaw (*Asimina triloba*)

Understory Associate

Spicebush (*Benzoin aestivale*)

Dominant Herbaceous Non-Grass Plant

Leafcup (*Polymnia canadensis*)

Other Herbaceous Non-Grass Plant Associates

Pale touch-me-not (*Impatiens pallida*)
Waterleaf (*Hydrophyllum appendiculatum*)
Yellow violet (*Viola eriocarpa* var. *leiocarpa*)
May-apple (*Podophyllum peltatum*)
Moonseed (*Menispermum canadense*)
Enchanter's nightshade (*Circaea latifolia*)
Wild ginger (*Asarum canadense* var. *acuminatum*)
Celandine poppy (*Stylophorum diphyllum*)

69. Rich, wooded, north-facing, limestone slopes along spring branch tributary to Swan Creek, sec. 34, T. 26 N., R. 19 W., four miles southeast of Chadwick, Christian County.

Dominant Trees

Black maple (*Acer nigrum*)
Chinquapin oak (*Quercus Muhlenbergii*)
Sugar maple (*Acer saccharum* var. *glaucum*)

Other Tree Associates

Northern red oak (*Quercus borealis* var. *maxima*)
Blue ash (*Fraxinus quadrangulata*)
Bur oak (*Quercus macrocarpa*)
American elm (*Ulmus americana*)

Dominant Understory

Pawpaw (*Asimina triloba*)
Bladdernut (*Staphylea trifolia*)
Spicebush (*Benzoin aestivale*)

Understory Associate

Arrow-wood (*Viburnum molle*)

Dominant Herbaceous Non-Grass Plants

Waterleaf (*Hydrophyllum appendiculatum*)
Leafcup (*Polymnia canadensis*)
Liverleaf (*Hepatica americana*)
Moonseed (*Menispermum canadense*)

Other Herbaceous Non-Grass Plant Associates

Cup-seed (*Calycocarpum Lyoni*)
False spikenard (*Smilacina racemosa*)

Dominant Grasses

Wild chess (*Bromus purgans*)
Fescue grass (*Festuca obtusa*)
Bottle brush (*Hystrix patula*)
Diarina festucoides

70. Northwest-facing wooded slopes along Swan Creek, sec. 34, T. 26 N., R. 19 W., four miles southeast of Chadwick, Christian County.

Dominant Trees

Black maple (*Acer nigrum*)
Sugar maple (*Acer saccharum* var. *glaucum*)
Linden (*Tilia glabra*)
Bitternut hickory (*Carya cordiformis*)

Other Tree Associates

White ash (*Fraxinus americana*)
Slippery elm (*Ulmus fulva*)

Dominant Understory

Arrow-wood (*Viburnum molle*)
Pawpaw (*Asimina triloba*)
Ironwood (*Carpinus caroliniana*)
Bladdernut (*Staphylea trifolia*)
Spicebush (*Benzoin aestivale*)

Understory Associate

Leatherwood (*Dirca palustris*)

Dominant Herbaceous Non-Grass Plants

Liverleaf (*Hepatica acutiloba*)
Early meadow rue (*Thalictrum dioicum*)
Black snakeroot (*Cimicifuga racemosa*)
Leafcup (*Polymnia canadensis*)

Other Herbaceous Non-Grass Plant Associates

Liverleaf (*Hepatica americana*)
Joe-Pye weed (*Eupatorium purpureum*)
Indian turnip (*Arisaema triphyllum*)
Wood's hellebore (*Veratrum Woodii*)

71. North-facing limestone slopes along valley bordering Stinson Creek, near Ballinger Springs, sec. 1, T. 46 N., R. 9 W., two miles northeast of Hams Prairie, Callaway County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Linden (*Tilia glabra*)
Black maple (*Acer nigrum*)

Other Tree Associates

Butternut (*Juglans cinerea*)
Bitternut hickory (*Carya cordiformis*)
Kentucky coffee tree (*Gymnocladus dioica*)

Dominant Understory

Pawpaw (*Asimina triloba*)
Alternate-leaved dogwood (*Cornus alternifolia*)
Ironwood (*Carpinus caroliniana*)
Bladdernut (*Staphylea trifolia*)

Understory Associate

Arrow-wood (*Viburnum molle*)

Dominant Herbaceous Non-Grass Plant

Woollen breeches (*Hydrophyllum appendiculatum*)

Other Herbaceous Non-Grass Plants

Celandine poppy (*Stylophorum diphyllum*)
Goldenrod (*Solidago latifolia*)
Clearweed (*Pilea pumila* var. *Deamii*)
Narrow-leaved spleenwort (*Athyrium pycnocarpon*)
Leafcup (*Polymnia canadensis*)
White avens (*Geum canadense* var. *camporum*)
Wild geranium (*Geranium maculatum*)
Bloodroot (*Sanguinaria canadensis*)
Spiderwort (*Tradescantia subaspera*)
Maidenhair fern (*Adiantum pedatum*)

72. North-facing limestone bluffs with wooded talus slopes below, along Osage River, sec. 2, T. 40 N., R. 13 W., west of Capps, Miller County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Chinquapin oak (*Quercus Muhlenbergii*)

Other Tree Associates

Linden (*Tilia glabra*)
Butternut (*Juglans cinerea*)
White oak (*Quercus alba*)
Northern red oak (*Quercus borealis* var. *maxima*)

Dominant Understory

American hornbeam (*Carpinus caroliniana*)
Bladdernut (*Staphylea trifolia*)
Flowering dogwood (*Cornus florida*)

Other Understory Associates

Benzoin (*Benzoin aestivale*)
Hydrangea (*Hydrangea arborescens*)
Pawpaw (*Asimina triloba*)

Dominant Herbaceous Non-Grass Plant

Goldenrod (*Solidago latifolia*)

73. North-facing limestone bluffs along Little Niangua River, sec. 5, T. 38 N., R. 18 W., two and one-half miles south of Barnumtown, Camden County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Black maple (*Acer nigrum*)
Bitternut hickory (*Carya cordiformis*)—at base

Other Tree Associates

Linden (*Tilia glabra*)
Butternut (*Juglans cinerea*)
Northern red oak (*Quercus borealis* var. *maxima*)

Dominant Understory

Bladdernut (*Staphylea trifolia*)
Benzoin (*Benzoin aestivale*)
Pawpaw (*Asimina triloba*)
American hornbeam (*Carpinus caroliniana*)

Dominant Herbaceous Non-Grass Plants

Pale touch-me-not (*Impatiens pallida*)
Leafcup (*Polymnia canadensis*)

Other Herbaceous Non-Grass Plants

Woollen breeches (*Hydrophyllum appendiculatum*)
Narrow-leaved spleenwort (*Athyrium pycnocarpon*)

74. West-facing, wooded, limestone slope along Brushy Creek, sec. 8, T. 27 N., R. 3 E., six miles north of Ellsinore, Carter County.

Dominant Tree

Sugar maple (*Acer saccharum* var. *glaucum*)

Other Tree Associates

Northern red oak (*Quercus borealis* var. *maxima*)
White oak (*Quercus alba*)
Chinquapin oak (*Quercus Muhlenbergii*)
Bitternut hickory (*Carya cordiformis*)
Shagbark hickory (*Carya ovata*)
White ash (*Fraxinus americana*)
Linden (*Tilia glabra*)
Mulberry (*Morus rubra*)
Slippery elm (*Ulmus fulva*)
Winged elm (*Ulmus alata*)

Chief Understory

Bladdernut (*Staphylea trifolia*)
Flowering dogwood (*Cornus florida*)

Other Understory Associates

Possum haw (*Ilex decidua*)
Chittim-wood (*Bumelia lanuginosa*)
Hackberry (*Celtis laevigata* var. *texana*)
Wild plum (*Prunus americana*)
American hornbeam (*Carpinus caroliniana*)
Hydrangea (*Hydrangea arborescens*)
Hop hornbeam (*Ostrya virginiana*)
Sassafras (*Sassafras albidum* var. *molle*)
Eastern witch hazel (*Hamamelis virginiana*)
Black haw (*Viburnum rufidulum*)
Redbud (*Cercis canadensis*)

Dominant Grass-like Plant

Carex eburnea

Other Grass or Grass-like Associates

Wild chess (*Bromus purgans*)
Indian grass (*Sorghastrum nutans*)
Fescue grass (*Festuca paradoxa*)
Blue-stem grass (*Andropogon scoparius*)

75. Lower portion of northeast-facing limestone slopes along St. Francis River, just west of Greenville, Wayne County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Chinquapin oak (*Quercus Muhlenbergii*)
Northern red oak (*Quercus borealis* var. *maxima*)

Dominant Understory

Black haw (*Viburnum rufidulum*)
White ash (*Fraxinus americana*)
Pawpaw (*Asimina triloba*)
Indian cherry (*Rhamnus caroliniana*)
Hazelnut (*Corylus americana*)
Redbud (*Cercis canadensis*)
Ironwood (*Carpinus caroliniana*)
Hop tree (*Ptelea trifoliata*)

Dominant Herbaceous Non-Grass Plants

Liverleaf (*Hepatica acutiloba*)
Early meadow rue (*Thalictrum dioicum*)

Dominant Grasses

Fescue grass (*Festuca obtusa*)
Sphenopholis (*Sphenopholis intermedia*)

76. North-facing, wooded, limestone slopes along Brushy Creek, sec. 8, T. 27 N., R. 3 E., six miles north of Ellsinore, Carter County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Northern red oak (*Quercus borealis* var. *maxima*)

Other Tree Associates

White oak (*Quercus alba*)
White ash (*Fraxinus americana*)
Bitternut hickory (*Carya cordiformis*)
Butternut (*Juglans cinerea*)
River birch (*Betula nigra*)
Sassafras (*Sassafras albidum* var. *molle*)
Red maple (*Acer rubrum*)
Sycamore (*Platanus occidentalis*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)

Dominant Understory

Dogwood (*Cornus florida*)
Ironwood (*Carpinus caroliniana*)

Other Understory Associates

Smooth alder (*Alnus rugosa*)
Buck brush (*Symphoricarpos orbiculatus*)
Black haw (*Viburnum rufidulum*)
Shadbush, serviceberry (*Amelanchier canadensis*)
American bladdernut (*Staphylea trifolia*)
Fragrant sumac (*Rhus aromatica*)
Redbud (*Cercis canadensis*)
Button-bush (*Cephalanthus occidentalis*)
Spicebush (*Benzoin aestivale*)
Hazelnut (*Corylus americana*)
Hop hornbeam (*Ostrya virginiana*)
Ozark witch hazel (*Hamamelis vernalis*)
Ward's willow (*Salix longipes* var. *Wardii*)
Hydrangea (*Hydrangea arborescens*)

Dominant Herbaceous Non-Grass Plant

Liverleaf (*Hepatica acutiloba*)

Dominant Grasses

Thin grass (*Agrostis perennans*)
Fowl meadow grass (*Glyceria striata*)

77. Rich, low woods and adjacent lower limestone slopes along spring branch tributary to Current River, sec. 34, T. 25 N., R. 1 E., six miles northeast of Bennett, Ripley County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Red maple (*Acer rubrum*)
Chinquapin oak (*Quercus Muhlenbergii*)
Bitternut hickory (*Carya cordiformis*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Red mulberry (*Morus rubra*)
Black walnut (*Juglans nigra*)
Linden (*Tilia glabra*)
White ash (*Fraxinus americana*)
Northern red oak (*Quercus borealis* var. *maxima*)
American elm (*Ulmus americana*)

Dominant Understory

Spicebush (*Benzoin aestivale*)
Hazelnut (*Corylus americana*)
Redbud (*Cercis canadensis*)
Ironwood (*Carpinus caroliniana*)
Pawpaw (*Asimina triloba*)
Bladdernut (*Staphylea trifolia*)

78. North-facing, wooded, limestone slopes along Big Creek, sec. 18, T. 31 N., R. 2 W., three miles northeast of Rat, Shannon County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
American linden (*Tilia glabra*)
Butternut (*Juglans cinerea*)

Dominant Understory

Eastern witch hazel (*Hamamelis virginiana*)
Spicebush (*Benzoin aestivale*)
Ohio buckeye (*Aesculus glabra* f. *pallida*)
Bladdernut (*Staphylea trifolia*)
Flowering dogwood (*Cornus florida*)
Running strawberry-bush (*Euonymus obovatus*)
Bristly greenbrier (*Smilax hispida*)

Dominant Herbaceous Non-Grass Plant

Wood's hellebore (*Veratrum Woodii*)

Dominant Grasses and Grass-like Plants

Brachyelytrum erectum
Sedge (*Carex eburnea*)

79. North-facing, wooded, limestone slopes along Bee Fork of Black River, sec. 23, T. 32 N., R. 1 W., four miles northwest of Centerville, Reynolds County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Northern red oak (*Quercus borealis* var. *maxima*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Butternut (*Juglans cinerea*)
Red mulberry (*Morus rubra*)
American elm (*Ulmus americana*)
Linden (*Tilia glabra*)
Bitternut hickory (*Carya cordiformis*)

Dominant Understory of Upper Portion

Eastern witch hazel (*Hamamelis virginiana*)
Hop hornbeam (*Ostrya virginiana*)
Redbud (*Cercis canadensis*)
Flowering dogwood (*Cornus florida*)
Juneberry, serviceberry (*Amelanchier canadensis*)

Dominant Understory of Lower Portion

Leatherwood (*Dirca palustris*)
Flowering dogwood (*Cornus florida*)
Spicebush (*Benzoin aestivale*)

Dominant Herbaceous Non-Grass Plant

Liverleaf (*Hepatica acutiloba*)

80. East-facing limestone slopes along Brushy Creek, sec. 24, T. 33 N., R. 1 W., one mile north of Moses Store, Reynolds County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
Linden (*Tilia glabra*)
Sugar maple (*Acer saccharum* var. *glaucum*)

Tree Associate

Black cherry (*Prunus serotina*)

Dominant Understory

Eastern witch hazel (*Hamamelis virginiana*)
Flowering dogwood (*Cornus florida*)

Other Understory Associates

Ironwood (*Carpinus caroliniana*)
Spicebush (*Benzoin aestivale*)
Leatherwood (*Dirca palustris*)
Juneberry, serviceberry (*Amelanchier canadensis*)
Sassafras (*Sassafras albidum* var. *molle*)

Dominant Herbaceous Non-Grass Plants

Early meadow rue (*Thalictrum dioicum*)
Liverleaf (*Hepatica acutiloba*)
Black cohosh (*Cimicifuga racemosa*)
Wild ginger (*Asarum canadense* var. *reflexum*)

81. West-facing, cherty limestone slopes along Otter Creek, sec. 18, T. 27 N., R. 6 E., near Taskee, Wayne County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Winged elm (*Ulmus alata*)
White oak (*Quercus alba*)
Northern red oak (*Quercus borealis* var. *maxima*)
Black walnut (*Juglans nigra*)
White ash (*Fraxinus americana*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Mockernut hickory (*Carya tomentosa*)

Dominant Understory

Dogwood (*Cornus florida*)
Fragrant sumac (*Rhus aromatica*)
Sassafras (*Sassafras albidum* var. *molle*)
American bladdernut (*Staphylea trifolia*)
Hop hornbeam (*Ostrya virginiana*)
Redbud (*Cercis canadensis*)
Shadbush (*Amelanchier canadensis*)
Indian cherry (*Rhamnus caroliniana*)
Ironwood (*Carpinus caroliniana*)

82. Base of rich, low, wooded slopes just above alluvial woods along Gasconade River, east of Mossy Spring, sec. 2, T. 36 N., R. 11 W., seven miles northeast of Waynesville, Pulaski County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
White oak (*Quercus alba* f. *latiloba*)
Bitternut hickory (*Carya cordiformis*)
Linden (*Tilia glabra*)

Other Tree Associates

Hackberry (*Celtis occidentalis* var. *canina*)
Slippery elm (*Ulmus fulva*)

Dominant Understory

Ironwood (*Carpinus caroliniana*)
Burning bush (*Euonymus atropurpureus*)
Pawpaw (*Asimina triloba*)

Other Understory Associates

Moonseed (*Menispermum canadense*)
Buck brush (*Symphoricarpos orbiculatus*)
Sassafras (*Sassafras albidum*)
Virginia creeper (*Parthenocissus quinquefolia*)

Dominant Herbaceous Non-Grass Plants

Pale touch-me-not (*Impatiens pallida*)
White crown-beard (*Verbesina virginica*)
Clearweed (*Pilea pumila* var. *Deamii*)
Pokeweed (*Phytolacca americana*)
White violet (*Viola striata*)
Wild ginger (*Asarum canadense* var. *acuminatum*)

Other Herbaceous Non-Grass Plant Associates

Blephilia (*Blephilia hirsuta*)
Wood nettle (*Laportea canadensis*)
Yellow violet (*Viola eriocarpa* var. *leiocarpa*)
Fragile fern (*Cystopteris fragilis* var. *protrusa*)
Hog-peanut (*Amphicarpa bracteata*)
Fragrant bedstraw (*Galium triflorum*)
Bloodroot (*Sanguinaria canadensis*)
Skullcap (*Scutellaria ovata*)
Joe-Pye weed (*Eupatorium purpureum*)
Wild yam (*Dioscorea villosa*)
Enchanter's nightshade (*Circaea latifolia*)
Wild blue phlox (*Phlox divaricata* var. *Laphamii*)
Vervain (*Verbena urticaefolia*)

83. East-facing, cherty, limestone slopes along Ottery Creek, sec. 34, T. 34 N., R. 1 E., two miles northeast of Edgehill, Iron County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Shagbark hickory (*Carya ovata*)
Northern red oak (*Quercus borealis* var. *maxima*)
Bitternut hickory (*Carya cordiformis*)
White ash (*Fraxinus americana*)
Linden (*Tilia glabra*)
White oak (*Quercus alba*)
Butternut (*Juglans cinerea*)

Dominant Understory

Flowering dogwood (*Cornus florida*)

84. West-facing, porphyritic, trachyte slopes along Ottery Creek, sec. 26, T. 34 N., R. 1 E., three miles northeast of Edgehill, Iron County.

Dominant Tree

Winged elm (*Ulmus alata*)

Other Tree Associates

Sugar maple (*Acer saccharum* var. *glaucum*)
White oak (*Quercus alba*)
Shagbark hickory (*Carya ovata*)

Dominant Understory

Hop hornbeam (*Ostrya virginiana*)
Hackberry (*Celtis laevigata* var. *texana*)

85. Limestone bluffs at mouth of spring branch of Pulltight Spring, Shannon County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Red cedar (*Juniperus virginiana*)
Chittim-wood (*Bumelia lanuginosa*)
Chinquapin oak (*Quercus Muhlenbergii*)
Schneck's red oak (*Quercus Shumardii* var. *Schneckii*)
Persimmon (*Diospyros virginiana*)

86. Rich, east-facing slopes at base of limestone bluffs along King's River, south of Prentiss Ford, sec. 24, T. 21 N., R. 25 W., five miles south of Viola, Barry County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Chinquapin oak (*Quercus Muhlenbergii*)
Northern red oak (*Quercus borealis* var. *maxima*)

Dominant Understory

Black locust (*Robinia Pseudo-acacia*)
Pawpaw (*Asimina triloba*)
Spicebush (*Benzoin aestivale*)
Redbud (*Cercis canadensis*)

87. Limestone draw between upper part of bald knob in Hercules Game Refuge, sec. 10–11, T. 24 N., R. 18 W., two miles southwest of Hercules, Taney County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Schneck's red oak (*Quercus Shumardii* var. *Schneckii*)
Smoke tree (*Cotinus americanus*)

Dominant Understory

Flowering dogwood (*Cornus florida*)
Swamp dogwood (*Cornus obliqua*)
Rough-leaved dogwood (*Cornus asperifolia*)
Possum haw (*Ilex decidua*)
Ninebark (*Physocarpus opulifolius* var. *intermedius*)
Andrachne phyllanthoides

Other Understory Associates

Indian cherry (*Rhamnus caroliniana*)
Fringe tree (*Chionanthus virginica*)

88. North-facing, wooded, limestone slopes along Pomme de Terre River, three miles northeast of Elkland, Hickory County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Northern red oak (*Quercus borealis* var. *maxima*)

Dominant Understory

Bladdernut (*Staphylea trifolia*)
Pawpaw (*Asimina triloba*)

Other Understory Associates

Prickly ash (*Zanthoxylum americanum*)
Bittersweet (*Celastrus scandens*)
Flowering dogwood (*Cornus florida*)
Burning bush (*Euonymus atropurpureus*)

Dominant Herbaceous Non-Grass Plants

Tick trefoil (*Desmodium acuminatum*)
Joe-Pye weed (*Eupatorium purpureum*)
Agrimony (*Agrimonia rostellata*)
Tall bellflower (*Campanula americana*)
Lopseed (*Phryma Leptostachya*)

Dominant Grass

Brachyelytrum erectum

89. Northeast-facing, wooded, limestone slopes at base of bluffs along Gasconade River, sec. 8, T. 36 N., R. 12 W., five miles northwest of Waynesville, Pulaski County.

Dominant Trees

Black maple (*Acer nigrum*)
Sugar maple (*Acer saccharum* var. *glaucum*)
Linden (*Tilia glabra*)
Northern red oak (*Quercus borealis* var. *maxima*)

Dominant Understory

Alternate-leaved dogwood (*Cornus alternifolia*)
Bladdernut (*Staphylea trifolia*)

Other Understory Associates

Arrow-wood (*Viburnum molle*)
Ironwood (*Carpinus caroliniana*)
Dogwood (*Cornus florida*)

90. North-facing, shaley, limestone slopes along Deepwater Creek, sec. 20, T. 40 N., R. 29 W., one and one-half miles southwest of Spruce, Bates County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
Black oak (*Quercus velutina*)
White oak (*Quercus alba*)

Dominant Understory

Rough-leaved dogwood (*Cornus asperifolia*)
Bladdernut (*Staphylea trifolia*)
Pawpaw (*Asimina triloba*)

91. Vertical, northeast-facing, limestone bluffs of Hall's Bluff, south of Davidson's Blue Spring, along Black River, sec. 4, T. 27 N., R. 4 E., four miles southeast of Mill Spring, Wayne County.

Dominant Shrubs

Poison ivy (*Toxicodendron radicans*)
Virginia creeper (*Parthenocissus quinquefolia*)
Hydrangea (*Hydrangea arborescens*)
Ninebark (*Physocarpus opulifolius* var. *intermedius*)

Dominant Herbaceous Non-Grass Plants

Alum root (*Heuchera parviflora* var. *Rugelii*)
Bulblet bladder fern (*Cystopteris bulbifera*)
Liverleaf (*Hepatica acutiloba*)
Rock cress (*Arabis laevigata*)
Cliffbrake (*Pellaea atropurpurea*)
Gray polypody (*Polypodium polypodioides* var. *Michauxianum*)

Dominant Grasses

Wild chess (*Bromus purgans*)
Bottlebrush (*Hystrix patula*)
Melic grass (*Melica mutica*)

92. North-facing, limestone slopes along Current River, sec. 3, T. 24 N., R. 1 E., five miles northeast of Bennett, Ripley County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Butternut (*Juglans cinerea*)
Northern red oak (*Quercus borealis* var. *maxima*)

Dominant Understory

American bladdernut (*Staphylea trifolia*)
Ironwood (*Carpinus caroliniana*)
Dogwood (*Cornus florida*)

Dominant Grasses and Grass-like Plants

Wild chess (*Bromus purgans*)
Sedge (*Carex eburnea*)

93. West-facing, limestone slopes along Coldwater Creek, sec. 15, T. 35 N., R. 8 E., five miles northeast of Womack, Sainte Genevieve County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Chinquapin oak (*Quercus Muhlenbergii*)

Dominant Understory

Redbud (*Cercis canadensis*)

94. Lower portion of north-facing, wooded, limestone slopes along spring branch of Montauk Spring, Montauk State Park, near Montauk, Dent County.

Dominant Tree

White oak (*Quercus alba*)

Other Tree Associates

Butternut (*Juglans cinerea*)
Chinquapin oak (*Quercus Muhlenbergii*)
Linden (*Tilia glabra*)

Dominant Understory

Pawpaw (*Asimina triloba*)
Spicebush (*Benzoin aestivale*)
Alternate-leaved dogwood (*Cornus alternifolia*)
Running strawberry-bush (*Euonymus obovatus*)
Bladdernut (*Staphylea trifolia*)

95. Upper portion of north-facing, wooded, limestone slopes along spring branch of Montauk Spring, Montauk State Park, near Montauk, Dent County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
Sugar maple (*Acer saccharum* var. *glaucum*)

Other Tree Associates

White ash (*Fraxinus americana*)
Slippery elm (*Ulmus fulva*)

Dominant Understory

Ironwood (*Carpinus caroliniana*)
Flowering dogwood (*Cornus florida*)

Understory Associate

Hop hornbeam (*Ostrya virginiana*)

96. East-facing upper portion of wooded limestone slopes along Hazel Creek, sec. 14, T. 36 N., R. 1 W., one mile southwest of Palmer, Washington County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Linden (*Tilia glabra*)
Butternut (*Juglans cinerea*)
Chinquapin oak (*Quercus Muhlenbergii*)

Dominant Understory

Bladdernut (*Staphylea trifolia*)

Other Understory Associates

Rough-leaved dogwood (*Cornus asperifolia*)
Flowering dogwood (*Cornus florida*)

97. Lower portion of east-facing limestone slopes along Hazel Creek, sec. 14, T. 36 N., R. 1 W., one mile southwest of Palmer, Washington County.

Dominant Tree

American elm (*Ulmus americana*)

Dominant Understory

Pawpaw (*Asimina triloba*)
Spicebush (*Benzoin aestivale*)

98. East-facing limestone slopes along Fourche à Renault Creek, sec. 15, T. 37 N., R. 1 E., one and one-half miles north of Shirley, Washington County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Linden (*Tilia glabra*)
Chinquapin oak (*Quercus Muhlenbergii*)

Other Tree Associates

Slippery elm (*Ulmus fulva*)
Butternut (*Juglans cinerea*)
Red cedar (*Juniperus virginiana*)
Red mulberry (*Morus rubra*)
Winged elm (*Ulmus alata*)

Dominant Understory

Hop hornbeam (*Ostrya virginiana*)
Chittim-wood (*Bumelia lanuginosa*)
Ironwood (*Carpinus caroliniana*)
Redbud (*Cercis canadensis*)

99. Intermediate zone of east-facing limestone slopes between upper, drier, cedar-clad slopes and lower, richer soil slopes along Fourche à Renault Creek, sec. 15, T. 37 N., R. 1 E., one and one-half miles north of Shirley, Washington County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Schneck's red oak (*Quercus Shumardii* var. *Schneckii*)
Linden (*Tilia glabra*)
Chinquapin oak (*Quercus Muhlenbergii*)
White ash (*Fraxinus americana*)
Winged elm (*Ulmus alata*)

Dominant Understory

Rough-leaved dogwood (*Cornus asperifolia*)
Hop hornbeam (*Ostrya virginiana*)
Redbud (*Cercis canadensis*)
Smooth sumac (*Rhus glabra*)
Buck brush (*Symphoricarpos orbiculatus*)
Ninebark (*Physocarpus opulifolius* var. *intermedius*)

100. Upland slopes following along gravel bar of Little Fourche à Renault Creek, sec. 2, T. 37 N., R. 1 E., two miles southeast of Floyd, Washington County.

Dominant Trees

White oak (*Quercus alba*)
Northern red oak (*Quercus borealis* var. *maxima*)
Mockernut hickory (*Carya tomentosa*)
Bitternut hickory (*Carya cordiformis*)
Black walnut (*Juglans nigra*)

Dominant Understory

Redbud (*Cercis canadensis*)

101. North-facing, wooded, limestone slopes along Big Creek, sec. 18, T. 31 N., R. 2 W., three miles northeast of Rat, Shannon County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Linden (*Tilia glabra*)
Butternut (*Juglans cinerea*)

Dominant Understory

Eastern witch hazel (*Hamamelis virginiana*)
Spicebush (*Benzoin aestivale*)
Ohio buckeye (*Aesculus glabra* f. *pallida*)
Running strawberry-bush (*Euonymus obovatus*)
Flowering dogwood (*Cornus florida*)
Bladdernut (*Staphylea trifolia*)

102. Acid, wooded valley floor along headwaters of branch south of Enough, Iron County.

Dominant Trees

White oak (*Quercus alba*)
Black oak (*Quercus velutina*)
Northern red oak (*Quercus borealis* var. *maxima*)

Other Tree Associates

Red maple (*Acer rubrum*)
Sycamore (*Platanus occidentalis*)
Butternut (*Juglans cinerea*)
Mockernut hickory (*Carya tomentosa*)
Honey locust (*Gleditsia triacanthos*)
Winged elm (*Ulmus alata*)
Sassafras (*Sassafras albidum* var. *molle*)
Bitternut hickory (*Carya cordiformis*)

Dominant Understory

Smooth alder (*Alnus rugosa*)
Ironwood (*Carpinus caroliniana*)
Ozark witch hazel (*Hamamelis vernalis*)
Flowering dogwood (*Cornus florida*)
Juneberry, serviceberry (*Amelanchier canadensis*)
Redbud (*Cercis canadensis*)
Hazelnut (*Corylus americana*)
Black haw (*Viburnum rufidulum*)
Hop hornbeam (*Ostrya virginiana*)
Bristly greenbrier (*Smilax hispida*)
Ward's willow (*Salix longipes* var. *Wardii*)

103. Valley floor of shallow ravine along headwaters of Sinking Creek, sec. 10, T. 32 N., R. 3 W., three miles northwest of Bunker, in Dent County.

Dominant Trees

Sycamore (*Platanus occidentalis*)
Bitternut hickory (*Carya cordiformis*)

Other Tree Associates

Slippery elm (*Ulmus fulva*)
Northern red oak (*Quercus borealis* var. *maxima*)
White oak (*Quercus alba*)
Black gum (*Nyssa sylvatica* var. *caroliniana*)
Shumard's red oak (*Quercus Shumardii*)

Dominant Understory

Buck brush (*Symphoricarpos orbiculatus*)
Hazelnut (*Corylus americanus*)

Other Understory Associates

Redbud (*Cercis canadensis*)
Ironwood (*Carpinus caroliniana*)
Flowering dogwood (*Cornus florida*)
Pawpaw (*Asimina triloba*)
Black haw (*Viburnum rufidulum*)
Smooth alder (*Alnus rugosa*)
Swamp dogwood (*Cornus obliqua*)
Ward's willow (*Salix longipes* var. *Wardii*)

104. Sandy, alluvial woods along Marble Creek opposite limestone bluffs, sec. 21, T. 32 N., R. 5 E., two and one-half miles southwest of French Mills, Madison County.

Dominant Trees

Red cedar (*Juniperus virginiana*)
Southern yellow pine (*Pinus echinata*)
Sugar maple (*Acer saccharum* var. *glaucum*)
White oak (*Quercus alba*)
Red maple (*Acer rubrum*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Chinquapin oak (*Quercus Muhlenbergii*)

Dominant Understory

Leatherwood (*Dirca palustris*)
Chittim-wood (*Bumelia lanuginosa*)
Ironwood (*Carpinus caroliniana*)
Indian cherry (*Rhamnus caroliniana* var. *mollis*)

III. QUERCUS–CARYA ASSOCIATION

(2) **Quercus marilandica–Quercus stellata** Associes

105. Upland, level, wooded ridge top between highway No. 32 and Dillard, Crawford County.

Dominant Trees

Post oak (*Quercus stellata*)
Black jack oak (*Quercus marilandica*)

Other Tree Associates

White oak (*Quercus alba*)
Black oak (*Quercus velutina*)

106. West-facing, upland, granite glade at Granite Bend, sec. 10, T. 27 N., R. 4 E., five miles northwest of Williamsville, Wayne County.

Dominant Trees

Post oak (*Quercus stellata*)
Black jack oak (*Quercus marilandica*)
Winged elm (*Ulmus alata*)
Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)

Dominant Herbaceous Non-Grass Plants

Crotonopsis elliptica
False aloe (*Agave virginica*)
Rock pink (*Talinum calycinum*)

Dominant Grasses and Grass-like Plants

Wild oats grass (*Danthonia spicata*)
Panic grass (*Panicum linearifolium*)
Slender fescue grass (*Festuca octoflora*)
Cyperus filiculmis var. *macilentus*

(3) **Quercus velutina–Carya Buckleyi** var. **arkansana** Associes

107. Upper valley wooded portion of Stilwell Hollow, in Low Gap Game Refuge, sec. 12, T. 32 N., R. 1 E., southeast of Black U. S. Lookout, four miles southwest of Black, Reynolds County.

Dominant Trees

Mockernut hickory (*Carya tomentosa*)
White oak (*Quercus alba*)
Black oak (*Quercus velutina*)
Shagbark hickory (*Carya ovata*)

Dominant Understory

Fragrant sumac (*Rhus aromatica*)

108. Upland oak–hickory woods in grazing plot southwest of Bunker CCC camp F-7, sec. 3, T. 33 N., R. 3 W., five miles northwest of Bunker, in Dent County.

Dominant Trees

White oak (*Quercus alba*)
Post oak (*Quercus stellata*)
Black oak (*Quercus velutina*)
Black jack oak (*Quercus marilandica*)
Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)
Black gum (*Nyssa sylvatica* var. *caroliniana*)
Mockernut hickory (*Carya tomentosa*)
Bitternut hickory (*Carya cordiformis*)
Shagbark hickory (*Carya ovata*)

Dominant Understory

Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)
Smooth sumac (*Rhus glabra*)

Dominant Grasses and Grass-like Plants

Wild oats grass (*Danthonia spicata*)
Panic grass (*Panicum lanuginosum* var. *fasciculatum*)
Panic grass (*Panicum linearifolium*)
Panic grass (*Panicum Boscii*)
Sedge (*Carex cephalophora*)
Panic grass (*Panicum dichotomum*)
Panic grass (*Panicum lanuginosum* var. *Lindheimeri*)
Blue-stem (*Andropogon scoparius* var. *genuinus*)

109. Level, upland, oak woods two miles northwest of Bunker CCC camp F-7, sec. 32, T. 33 N., R. 3 W., seven miles northwest of Bunker, in Dent County.

Dominant Trees

White oak (*Quercus alba*)
Post oak (*Quercus stellata*)
Black oak (*Quercus velutina*)

Other Tree Associates

Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)
Mockernut hickory (*Carya tomentosa*)
Sassafras (*Sassafras albidum* var. *molle*)
Shagbark hickory (*Carya ovata*)

Dominant Understory

Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)
Hazelnut (*Corylus americana*)
Flowering dogwood (*Cornus florida*)

Dominant Herbaceous Non-Grass Plant

Bush clover (*Lespedeza procumbens*)

Dominant Grasses and Grass-like Plants

Wild oats grass (*Danthonia spicata*)
Sedge (*Carex retroflexa*)
Sedge (*Carex artitecta*)

110. Upland cherty woods, sec. 7, T. 25 N., R. 4 E., 10 miles southeast of Ellsinore, Carter County.

Dominant Trees

Scarlet oak (*Quercus coccinea*)
Post oak (*Quercus stellata*)

Other Tree Associates

Black oak (*Quercus velutina*)
Black jack oak (*Quercus marilandica*)
White oak (*Quercus alba*)
Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)

Dominant Understory

Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)
Dwarf sumac (*Rhus Copallina*)

Understory Associate

Sassafras (*Sassafras albidum* var. *molle*)

Dominant Herbaceous Non-Grass Plants

Cinquefoil (*Potentilla simplex*)
Goat's rue (*Tephrosia virginiana*)
Dittany (*Cunila origanoides*)
Bush clover (*Lespedeza procumbens*)
Pussy toes (*Antennaria plantaginifolia*)

Herbaceous Non-Grass Associate

Forked chickweed (*Paronychia fastigiata* var. *typica*)

Dominant Grasses and Grass-like Plants

Sedge (*Carex hirsutella*)
Wild oats grass (*Danthonia spicata*)

Grass Associate

Hair grass (*Agrostis hyemalis*)

111. Upland oak–hickory woods, sec. 20 and 21, T. 26 N., R. 7 E., three miles north of Rombauer, Butler County.

Dominant Trees

Scarlet oak (*Quercus coccinea*)
Black oak (*Quercus velutina*)
Post oak (*Quercus stellata*)
Southern red oak (*Quercus falcata*)
Winged elm (*Ulmus alata*)
Black jack oak (*Quercus marilandica*)
Shagbark hickory (*Carya ovata*)
Mockernut hickory (*Carya Buckleyi* var. *arkansana*)

Dominant Understory

Fragrant sumac (*Rhus aromatica*)
Dwarf sumac (*Rhus Copallina*)
Sassafras (*Sassafras albidum* var. *molle*)

Dominant Herbaceous Non-Grass Plants

Pussy toes (*Antennaria plantaginifolia*)
Cinquefoil (*Potentilla simplex*)
Goat's rue (*Tephrosia virginiana*)
Pencil flower (*Stylosanthes biflora* var. *hispidissima*)
Sensitive pea (*Cassia nictitans*)
Field goldenrod (*Solidago nemoralis*)
Bush clover (*Lespedeza procumbens*)
Tick trefoil (*Desmodium obtusum*)
Dittany (*Cunila origanoides*)
Pinweed (*Lechea villosa*)
Bush clover (*Lespedeza repens*)
Bergamot (*Monarda Bradburiana*)
Bastard toadflax (*Comandra Richardsiana*)
Wild aster (*Aster patens*)
Brown-eyed Susan (*Rudbeckia hirta*)

Dominant Grasses and Grass-like Plants

Wild oats grass (*Danthonia spicata*)
Beard grass (*Andropogon virginicus* var. *genuinus*)
Sphenopholis (*Sphenopholis nitida*)
Paspalum (*Paspalum ciliatifolium* var. *Muhlenbergii*)

112. Upper, cherty slopes above limestone bluffs along Hazel Creek, sec. 14, T. 36 N., R. 1 W., one mile southwest of Palmer, Washington County.

Dominant Trees

Black oak (*Quercus velutina*)
White oak (*Quercus alba*)
Northern red oak (*Quercus borealis* var. *maxima*)

Other Tree Associates

Black gum (*Nyssa sylvatica* var. *caroliniana*)
Red maple (*Acer rubrum*)
Sassafras (*Sassafras albidum* var. *molle*)

113. West-facing, porphyritic trachyte slopes of Johnson Mountain, sec. 24, T. 35 N., R. 1 E., two miles south of Peoria, Iron County.

Dominant Trees

Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)
Shagbark hickory (*Carya ovata*)
Black jack oak (*Quercus marilandica*)
Post oak (*Quercus stellata*)

Dominant Understory

Fragrant sumac (*Rhus aromatica*)

Other Understory Associates

Flowering dogwood (*Cornus florida*)
High-bush huckleberry (*Vaccinium stamineum*)
Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)

114. Porphyritic trachyte outcrops on top of Johnson Mountain, sec. 24, T. 35 N., R. 1 E., two miles south of Peoria, Iron County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)
Post oak (*Quercus stellata*)

Dominant Understory

Winged sumac (*Rhus Copallina*)
Fragrant sumac (*Rhus aromatica*)
Smooth sumac (*Rhus glabra*)

Dominant Grasses and Grass-like Plants

Big blue-stem (*Andropogon provincialis*)
Panic grass (*Panicum lanuginosum* var. *fasciculatum*)
Fescue grass (*Festuca octoflora* var. *tenella*)
Sedge (*Carex artitecta*)

115. Upland, level, oak woods near Dillard, Crawford County.

Dominant Trees

Scarlet oak (*Quercus coccinea*)
Black jack oak (*Quercus marilandica*)

Other Tree Associates

White oak (*Quercus alba*)
Black oak (*Quercus velutina*)

Dominant Understory

Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)

116. Cherty upper slope south of Black, sec. 33, T. 33 N., R. 1 E., Reynolds County.

Dominant Trees

Black oak (*Quercus velutina*)
Mockernut hickory (*Carya tomentosa*)
White oak (*Quercus alba*)
Shagbark hickory (*Carya ovata*)
Scarlet oak (*Quercus coccinea*)
Red mulberry (*Morus rubra*)

Dominant Understory

Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)
Winged sumac (*Rhus Copallina*)
Fragrant sumac (*Rhus aromatica*)
Smooth sumac (*Rhus glabra*)
Sassafras (*Sassafras albidum* var. *molle*)
Bristly greenbrier (*Smilax hispida*)
Dewberry (*Rubus flagellaris*)

117. Upper south-facing portion near top of Little Pilot Knob, sec. 36, T. 38 N., R. 1 W., three miles northwest of Floyd, Washington County.

Dominant Trees

Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)
Northern red oak (*Quercus borealis* var. *maxima*)
Shingle oak (*Quercus imbricaria*)
Black oak (*Quercus velutina*)
White oak (*Quercus alba*)
Post oak (*Quercus stellata*)

Dominant Understory

High-bush huckleberry (*Vaccinium stamineum* var. *neglectum*)
Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)

118. Porphyritic trachyte soil on top of Little Pilot Knob, sec. 36, T. 38 N., R. 1 W., three miles northwest of Floyd, Washington County.

Dominant Trees

White oak (*Quercus alba*)
Post oak (*Quercus stellata*)

Other Tree Associates

Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)
Shagbark hickory (*Carya ovata*)

Dominant Understory

Smooth sumac (*Rhus glabra*)

119. Upper east-facing portion near top of Little Pilot Knob, sec. 36, T. 38 N., R. 1 W., three miles northwest of Floyd, Washington County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
Shagbark hickory (*Carya ovata*)
White oak (*Quercus alba*)
Black oak (*Quercus velutina*)

Dominant Understory

Juneberry, serviceberry (*Amelanchier canadensis*)
New Jersey tea (*Ceanothus americanus*)
Flowering dogwood (*Cornus florida*)

120. Upland oak–hickory woods, sec. 20 and 21, T. 26 N., R. 7 E., three miles northwest of Rombauer, Butler County.

Dominant Trees

Black oak (*Quercus velutina*)
White oak (*Quercus alba*)
Black jack oak (*Quercus marilandica*)
Scarlet oak (*Quercus coccinea*)
Shingle oak (*Quercus imbricaria*)
Ozark hickory (*Carya Buckleyi* var. *arkansana*)
Shagbark hickory (*Carya ovata*)

Dominant Understory

Farkleberry (*Vaccinium arboreum* var. *glaucescens*)

121. South-facing wooded slopes by headwaters of Meramec River along dry bed of river, sec. 14, T. 33 N., R. 4 W., two miles southeast of Max, Dent County.

Dominant Trees

Post oak (*Quercus stellata*)
Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)
Black jack oak (*Quercus marilandica*)
Shagbark hickory (*Carya ovata*)
Mockernut hickory (*Carya tomentosa*)

122. North-facing wooded slopes by headwaters of Meramec River along dry bed of river, sec. 14, T. 33 N., R. 4 W., two miles southeast of Max, Dent County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
White oak (*Quercus alba*)
Black oak (*Quercus velutina*)

IV. QUERCUS–PINUS ECHINATA ASSOCIATION

(2b) Quercus marilandica–Quercus stellata–Pinus echinata Associes

123. Woods off North Fork Hollow, near Cane Creek, sec. 8, T. 26 N., R. 4 E., six miles east of Ellsinore, south of Upalika, near Wayne County line, in Butler County.

Dominant Tree

Southern yellow pine (*Pinus echinata*)

Subdominant Trees

Post oak (*Quercus stellata*)
Black jack oak (*Quercus marilandica*)

Chief Understory

White oak (*Quercus alba* f. *latiloba*)
Fragrant sumac (*Rhus aromatica*)
Winged sumac (*Rhus Copallina*)
Winged elm (*Ulmus alata*)
Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)
Ozark hickory (*Carya Buckleyi* var. *arkansana*)
Mockernut hickory (*Carya tomentosa*)
Shingle oak (*Quercus imbricaria*)
Shagbark hickory (*Carya ovata*)

Dominant Herbaceous Non-Grass Plants

Pussy toes (*Antennaria plantaginifolia*)
Bush clover (*Lespedeza procumbens*)
Bush clover (*Lespedeza repens*)

Dominant Grass

Wild oats grass (*Danthonia spicata*)

123a. Pine stand on southeast-facing portion of porphyritic trachyte slopes of Little Pilot Knob, sec. 36, T. 38 N., R. 1 W., three miles northwest of Floyd, Washington County.

Dominant Tree

Southern yellow pine (*Pinus echinata*)

Tree Associate

Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)

Dominant Understory

Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)

Dominant Herbaceous Non-Grass Plants

Dittany (*Cunila origanoides*)
Aster (*Aster patens*)
Pussy toes (*Antennaria plantaginifolia*)

Dominant Grasses and Grass-like Plants

Panic grass (*Panicum lanuginosum* var. *fasciculatum*)
Sedge (*Carex hirsutella*)
Sedge (*Carex artitecta*)
Wild oats grass (*Danthonia spicata*)

(2c) **Mixed Oak–Hickory–Pine** Associes

124. Upper wooded ravine slopes of Stilwell Hollow, in Low Gap Game Refuge, sec. 12, T. 32 N., R. 1 E., southeast of Black U. S. Lookout, four miles southwest of Black, Reynolds County.

Dominant Trees

Black oak (*Quercus velutina*)
Scarlet oak (*Quercus coccinea*)

Other Tree Associates

Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)
Southern yellow pine (*Pinus echinata*)
Slippery elm (*Ulmus fulva*)

Dominant Grass

Wild chess (*Bromus purgans*)

125. Upland cherty ridge near Cornwall, Madison County.

Dominant Trees

Scarlet oak (*Quercus coccinea*)
Black oak (*Quercus velutina*)
White oak (*Quercus alba*)
Southern yellow pine (*Pinus echinata*)

Other Tree Associates

Post oak (*Quercus stellata*)
Mockernut hickory (*Carya tomentosa*)
Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)

126. Upper, cherty, west-facing slopes along Eleven Points River, sec. 11, T. 24 N., R. 3 W., one mile southeast of Turner's Mill, four miles southwest of Wilderness, Oregon County.

Dominant Trees

Southern yellow pine (*Pinus echinata*)
White oak (*Quercus alba*)
Black oak (*Quercus velutina*)
Red maple (*Acer rubrum*)
Mockernut hickory (*Carya tomentosa*)
Shagbark hickory (*Carya ovata*)
Black jack oak (*Quercus marilandica*)

Dominant Understory

Dogwood (*Cornus florida*)
Fragrant sumac (*Rhus aromatica*)

Dominant Herbaceous Non-Grass Plants

Goat's rue (*Tephrosia virginiana*) Dittany (*Cunila origanoides*)

Dominant Grass

Panic grass (*Panicum dichotomum*)

127. Upper, west-facing, cherty slopes, sec. 7, T. 25 N., R. 4 E., 10 miles southeast of Ellsinore, Carter County.

Dominant Tree

Southern yellow pine (*Pinus echinata*)

Other Tree Associates

White oak (*Quercus alba*)
Scarlet oak (*Quercus coccinea*)
Post oak (*Quercus stellata*)
Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)

Dominant Understory

Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)

Dominant Herbaceous Non-Grass Plants

Dittany (*Cunila origanoides*)
Bush clover (*Lespedeza hirta*)
Goat's rue (*Tephrosia virginiana*)

Dominant Grasses and Grass-like Plants

Sedge (*Carex hirsutella*) Panic grass (*Panicum dichotomum*)

128. Upland, cherty, sandstone area, sec. 22, T. 26 N., R. 3 E., three miles south of Ellsinore, Carter County.

Dominant Trees

Southern yellow pine (*Pinus echinata*)
Scarlet oak (*Quercus coccinea*)
Spanish oak (*Quercus falcata*)
Black oak (*Quercus velutina*)
Black jack oak (*Quercus marilandica*)
Ozark hickory (*Carya Buckleyi* var. *arkansana*)

Dominant Understory

Winged sumac (*Rhus Copallina*) Sassafras (*Sassafras albidum* var. *molle*)

Dominant Herbaceous Non-Grass Plants

Dittany (*Cunila origanoides*)
Pussy toes (*Antennaria plantaginifolia*)
Bush clover (*Lespedeza procumbens*)
Catgut, goat's rue (*Tephrosia virginiana*)
Bush clover (*Lespedeza repens*)

129. Cherty, steep exposures above bluffs along Huzzah Creek, two miles southeast of Davisville, Crawford County.

Dominant Trees

Post oak (*Quercus stellata*)
Black oak (*Quercus velutina*)
Winged elm (*Ulmus alata*)
Northern red oak (*Quercus borealis* var. *maxima*)

Tree Associate

Southern yellow pine (*Pinus echinata*)

Dominant Understory

Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)

Understory Associate

Hop hornbeam (*Ostrya virginiana*)

130. Cherty slopes along Stilwell Hollow, Low Gap Game Refuge, southeast of Black U. S. Lookout, sec. 12, T. 32 N., R. 1 E., four miles southwest of Black, Reynolds County.

Dominant Trees

Scarlet oak (*Quercus coccinea*)
Black oak (*Quercus velutina*)

Other Tree Associates

Southern yellow pine (*Pinus echinata*)
Mockernut hickory (*Carya tomentosa*)
Shagbark hickory (*Carya ovata*)
Post oak (*Quercus stellata*)

131. Cherty ridge top above limestone slopes along Fourche à Renault Creek, sec. 15, T. 37 N., R. 1 E., one and one-half miles north of Shirley, Washington County.

Dominant Trees

Black jack oak (*Quercus marilandica*)
Post oak (*Quercus stellata*)
Shagbark hickory (*Carya ovata*)
Scarlet oak (*Quercus coccinea*)
Black walnut (*Juglans nigra*)
White oak (*Quercus alba*)
Southern yellow pine (*Pinus echinata*)
Bitternut hickory (*Carya cordiformis*)

Dominant Understory

High-bush huckleberry (*Vaccinium stamineum* var. *neglectum*)
Flowering dogwood (*Cornus florida*)
Winged sumac (*Rhus Copallina*)

132. East-facing cherty slopes above limestone bluffs along Brazil Creek, sec. 28, T. 38 N., R. 1 W., six miles northeast of Berryman, Washington County.

Dominant Trees

Southern yellow pine (*Pinus echinata*)
Post oak (*Quercus stellata*)
Black jack oak (*Quercus marilandica*)
Shagbark hickory (*Carya ovata*)
Black oak (*Quercus velutina*)
Black walnut (*Juglans nigra*)

Dominant Understory

High-bush huckleberry (*Vaccinium stamineum* var. *neglectum*)

133. Cherty slopes along Coldwater Creek, sec. 33, T. 35 N., R. 8 E., three miles northeast of Womack, St. Francois County.

Dominant Trees

White oak (*Quercus alba*)
Black oak (*Quercus velutina*)
Scarlet oak (*Quercus coccinea*)
Southern yellow pine (*Pinus echinata*)

Other Tree Associates

Post oak (*Quercus stellata*)
Black jack oak (*Quercus marilandica*)
Shagbark hickory (*Carya ovata*)
Northern red oak (*Quercus borealis* var. *maxima*)

Dominant Understory

Red maple (*Acer rubrum*)
Flowering dogwood (*Cornus florida*)
Azalea (*Rhododendron nudiflorum* var. *roseum*)
Sassafras (*Sassafras albidum* var. *molle*)
Farkleberry (*Vaccinium arboreum* var. *glaucescens*)
Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)

134. Upland, level, wooded tract, just east of Bardley CCC camp, sec. 23, T. 24 N., R. 2 W., one and one-half miles west of Pine, in Ripley County.

Dominant Trees

Black jack oak (*Quercus marilandica*)
Shagbark hickory (*Carya ovata*)

Other Tree Associates

Southern yellow pine (*Pinus echinata*)
Scarlet oak (*Quercus coccinea*)
Post oak (*Quercus stellata*)
White oak (*Quercus alba*)
Southern red oak (*Quercus falcata*)
Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)

Dominant Understory

Dwarf sumac (*Rhus Copallina*)
New Jersey tea (*Ceanothus americanus*)

Other Understory Associates

Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)
High-bush huckleberry (*Vaccinium stamineum* var. *neglectum*)
Summer grape (*Vitis aestivalis*)
Smooth sumac (*Rhus glabra*)
Dogwood (*Cornus florida*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)

Dominant Herbaceous Non-Grass Plant

Bush clover (*Lespedeza procumbens*)

Dominant Grasses

Panic grass (*Panicum dichotomum*)
Panic grass (*Panicum sphaerocarpon*)
Panic grass (*Panicum Boscii*)

135. Ridge top in sec. 30, T. 26 N., R. 4 E., six miles southeast of Ellsinore, in Carter County.

Dominant Trees

Scarlet oak (*Quercus coccinea*)
Southern yellow pine (*Pinus echinata*)

Other Tree Associates

Black oak (*Quercus velutina*)
Spanish oak (*Quercus falcata*)
White oak (*Quercus alba*)
Post oak (*Quercus stellata*)
Black jack oak (*Quercus marilandica*)
Pignut hickory (*Carya ovalis* var. *obovalis*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)

Chief Understory

Winged sumac (*Rhus Copallina*)
Farkleberry (*Vaccinium arboreum* var. *glaucescens*)
Catbrier (*Smilax glauca* var. *leurophylla*)

Other Understory Associates

Staghorn sumac (*Rhus glabra*)
Fragrant sumac (*Rhus aromatica*)
Flowering dogwood (*Cornus florida*)
Persimmon (*Diospyros virginiana*)

Dominant Herbaceous Non-Grass Plants

Pinweed (*Lechea tenuifolia*)
Cinquefoil (*Potentilla simplex* var. *typica*)
Horsemint (*Monarda Bradburiana*)
Pennyroyal (*Hedeoma pulegioides*)
Dittany (*Cunila origanoides*)

Other Herbaceous Associates

Bush clover (*Lespedeza procumbens*)
Bush clover (*Lespedeza virginica*)
Sweet everlasting (*Gnaphalium obtusifolium*)
Bush clover (*Lespedeza repens*)
Forked chickweed (*Paronychia fastigiata* var. *typica*)
Fleabane (*Erigeron ramosus*)

Dominant Grasses and Grass-like Plants

Panic grass (*Panicum lanuginosum* var. *fasciculatum*)
Panic grass (*Panicum dichotomum*)
Rush (*Juncus macer*)

Other Grasses and Grass-like Associates

Poverty grass (*Aristida dichotoma*)
Sedge (*Carex hirsutella*)

136. West-facing, cherty, limestone slopes along Fourche à Renault Creek, sec. 15, T. 37 N., R. 1 E., one and one-half miles north of Shirley, Washington County.

Dominant Trees

Southern yellow pine (*Pinus echinata*)
White oak (*Quercus alba*)
Scarlet oak (*Quercus coccinea*)

Other Tree Associates

Black walnut (*Juglans nigra*)
Sassafras (*Sassafras albidum* var. *molle*)
Shingle oak (*Quercus imbricaria*)
Black gum (*Nyssa sylvatica* var. *caroliniana*)

Dominant Understory

Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)

Other Understory Associates

Farkleberry (*Vaccinium arboreum* var. *glaucescens*)
Winged sumac (*Rhus Copallina*)

Dominant Herbaceous Non-Grass Plants

Dittany (*Cunila origanoides*)
Pussy toes (*Antennaria plantaginifolia*)

Dominant Grasses and Grass-like Plants

Blue-stem (*Andropogon scoparius* var. *genuinus*)
Sedge (*Carex artitecta*)
Wild oats grass (*Danthonia spicata*)
Broom sedge (*Andropogon virginicus* var. *genuinus*)

137. South and southeast-facing, porphyritic trachyte slopes of Johnson Mountain, sec. 24, T. 35 N., R. 1 E., two miles south of Peoria, Iron County.

Dominant Trees

White oak (*Quercus alba*)
Scarlet oak (*Quercus coccinea*)
Black oak (*Quercus velutina*)
Southern yellow pine (*Pinus echinata*)
Black gum (*Nyssa sylvatica* var. *caroliniana*)
Post oak (*Quercus stellata*)
Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)
Northern red oak (*Quercus borealis* var. *maxima*)
Sassafras (*Sassafras albidum* var. *molle*)
Shagbark hickory (*Carya ovata*)
Red maple (*Acer rubrum*)

Dominant Understory

Flowering dogwood (*Cornus florida*)
Farkleberry (*Vaccinium arboreum* var. *glaucescens*)
Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)
Winged sumac (*Rhus Copallina*)

V. QUERCUS ALBA–ACER RUBRUM ASSOCIATION

(1) Cornus florida–Nyssa sylvatica Associes

138. Gravelly draw in upland, level woods around Little Scotia Pond, sec. 25-26, T. 33 N., R. 4 W., four miles east of Turtle, Dent County.

Dominant Trees

Red maple (*Acer rubrum*)
Flowering dogwood (*Cornus florida*)

Dominant Understory

Farkleberry (*Vaccinium arboreum* var. *glaucescens*)
Shrubby St. John's-wort (*Hypericum prolificum*)

(2) Acer rubrum–Carya tomentosa Associes

139. Cherty upper slopes overlying cherty acid soil between Saunders and Pine Ridge, Christian County.

Dominant Trees

Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Red maple (*Acer rubrum*)

Tree Associate

Southern yellow pine (*Pinus echinata*)

Dominant Understory

Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)

Other Understory Associates

Wild rose (*Rosa carolina*)
Wild rose (*Rosa subserrulata*)

Dominant Herbaceous Non-Grass Plant

Flowering spurge (*Euphorbia corollata*)

Dominant Grass

Broom sedge (*Andropogon virginicus* var. *genuinus*)

140. North-facing, porphyritic trachyte slopes of Johnson Mountain, sec. 24, T. 35 N., R. 1 E., two miles south of Peoria, Iron County.

Dominant Trees

White oak (*Quercus alba*)
Northern red oak (*Quercus borealis* var. *maxima*)
Red maple (*Acer rubrum*)
Black gum (*Nyssa sylvatica* var. *caroliniana*)
Shagbark hickory (*Carya ovata*)
Mockernut hickory (*Carya tomentosa*)

Dominant Understory

Flowering dogwood (*Cornus florida*)

141. Lower cherty slopes of Stilwell Hollow, Low Gap Game Refuge, southeast of Black U. S. Lookout, sec. 12, T. 32 N., R. 1 E., four miles southwest of Black, Reynolds County.

Dominant Trees

Southern yellow pine (*Pinus echinata*)
Red maple (*Acer rubrum*)

Dominant Understory

Hop hornbeam (*Ostrya virginiana*)
Serviceberry, Juneberry (*Amelanchier canadensis*)
Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)
Wild honeysuckle (*Lonicera flava*)
Smooth sumac (*Rhus glabra*)
Winged sumac (*Rhus Copallina*)
High-bush huckleberry (*Vaccinium stamineum* var. *neglectum*)
Farkleberry (*Vaccinium arboreum* var. *glaucescens*)

142. Slight draw on upper south-facing portion of porphyritic trachyte slopes of Little Pilot Knob, sec. 36, T. 38 N., R. 1 W., three miles northwest of Floyd, Washington County.

Dominant Trees

Red maple (*Acer rubrum*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Black oak (*Quercus velutina*)
Sassafras (*Sassafras albidum* var. *molle*)
Southern yellow pine (*Pinus echinata*)
White oak (*Quercus alba*)

(3) **Quercus alba–Acer rubrum** Associes

143. Draw in ravine in pine–oak woods south of Bunker CCC camp F-7, sec. 3, T. 32 N., R. 3 W., five miles northwest of Bunker, near Reynolds County line, in Dent County.

Dominant Trees

Red maple (*Acer rubrum*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Ozark pignut hickory (*Carya Buckleyi* var. *arkansana*)
White oak (*Quercus alba*)

Dominant Understory

Hazelnut (*Corylus americana*)
Dwarf sumac (*Rhus Copallina*)
Sassafras (*Sassafras albidum* var. *molle*)

144. Cherty, sandstone, shallow slopes along headwaters of Big Creek, sec. 10, T. 31 N., R. 3 W., south of Bunker U. S. Lookout, five miles southwest of Bunker, in Shannon County.

Dominant Trees

Mockernut hickory (*Carya tomentosa*)
White oak (*Quercus alba*)
Northern red oak (*Quercus borealis* var. *maxima*)

Other Tree Associates

Scarlet oak (*Quercus coccinea*)
Southern yellow pine (*Pinus echinata*)
Sassafras (*Sassafras albidum* var. *molle*)
Winged elm (*Ulmus alata*)
Red maple (*Acer rubrum*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)

Dominant Understory

Ozark witch hazel (*Hamamelis vernalis*) Buck brush (*Symphoricarpos orbiculatus*)

Other Understory Associates

Flowering dogwood (*Cornus florida*)
Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)
Juneberry, serviceberry (*Amelanchier canadensis*)
Black haw (*Viburnum rufidulum*)

145. Cherty, upper, south-facing slopes along Big Barren Creek, sec. 4, T. 25 N., R. 1 W., three miles southwest of Eastwood, 10 miles northwest of Bennett, Carter County.

Dominant Trees

White oak (*Quercus alba*)
Southern yellow pine (*Pinus echinata*)
Red maple (*Acer rubrum*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)

Other Tree Associates

Post oak (*Quercus stellata*) Scarlet oak (*Quercus coccinea*)

Dominant Understory

Shadbush (*Amelanchier canadensis*)

Other Understory Associates

Fragrant sumac (*Rhus aromatica*)
Dwarf sumac (*Rhus Copallina*)
Hazelnut (*Corylus americana*)
Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)
High-bush huckleberry (*Vaccinium stamineum* var. *neglectum*)
Farkleberry (*Vaccinium arboreum* var. *glaucescens*)

Dominant Herbaceous Non-Grass Plants

Dittany (*Cunila origanoides*)
Bracken fern (*Pteridium latiusculum* var. *pseudocaudatum*)
Bush clover (*Lespedeza hirta*)
Tick trefoil (*Desmodium marilandicum*)
Tick trefoil (*Desmodium rotundifolium*)
Goat's rue (*Tephrosia virginiana*)
Christmas fern (*Polystichum acrostichoides*)

Dominant Grass

Fescue grass (*Festuca paradoxa*)

146. Cherty slopes along headwaters of Big Creek, sec. 5, T. 31 N., R. 3 W., two miles south of Melton, Shannon County.

Dominant Trees

White oak (*Quercus alba*) Scarlet oak (*Quercus coccinea*)

Other Tree Associates

Southern yellow pine (*Pinus echinata*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Red maple (*Acer rubrum*)
Black oak (*Quercus velutina*)

147. Wooded, north-facing, cherty slopes along Eleven Points River between mouth of White's Creek and Bliss Spring, sec. 7, T. 24 N., R. 2 W., two and one-half miles southwest of Wilderness, Oregon County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
Bitternut hickory (*Carya cordiformis*)
White oak (*Quercus alba*)
Scarlet oak (*Quercus coccinea*)

Other Tree Associates

Sassafras (*Sassafras albidum* var. *molle*)
Red maple (*Acer rubrum*)
Mockernut hickory (*Carya tomentosa*)
Dogwood (*Cornus florida*)
Red mulberry (*Morus rubra*)
Persimmon (*Diospyros virginiana*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Slippery elm (*Ulmus fulva*)

Dominant Understory

Pink azalea (*Rhododendron nudiflorum* var. *roseum*)
Hazelnut (*Corylus americana*)
Redbud (*Cercis canadensis*)
Shadbush (*Amelanchier canadensis*)
Pawpaw (*Asimina triloba*)
Hop hornbeam (*Ostrya virginiana*)
Smooth sumac (*Rhus glabra*)
Rough-leaved dogwood (*Cornus asperifolia*)
Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)

148. Cherty slopes south of Rockhouse Spring, sec. 33, T. 23 N., R. 26 W., two miles west of Lohmer, Barry County.

Dominant Trees

Black oak (*Quercus velutina*)
White oak (*Quercus alba*)
Red maple (*Acer rubrum*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Chinquapin (*Castanea ozarkensis*)

Other Tree Associates

Northern red oak (*Quercus borealis* var. *maxima*)
Mockernut hickory (*Carya tomentosa*)

Dominant Understory

Flowering dogwood (*Cornus florida*)
Juneberry, serviceberry (*Amelanchier canadensis*)
Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)

Other Understory Associates

High-bush huckleberry (*Vaccinium stamineum*)
Hazelnut (*Corylus americana*)

Dominant Herbaceous Non-Grass Plants

Bracken (*Pteridium latiusculum* var. *pseudocaudatum*)
Dittany (*Cunila origanoides*)
Pussy toes (*Antennaria plantaginifolia*)
Horsemint (*Monarda Bradburiana*)

Other Herbaceous Non-Grass Plant Associates

Dwarf dandelion (*Krigia biflora*)
Bedstraw (*Galium arkansanum*)
Rue anemone (*Anemonella thalictroides*)
Tick trefoil (*Desmodium rotundifolium*)
Tick trefoil (*Desmodium Dillenii*)
Bush clover (*Lespedeza hirta*)
Black cohosh (*Cimicifuga racemosa*)
Bush clover (*Lespedeza procumbens*)
Lead plant (*Amorpha canescens* f. *glabrata*)
Bracted wild indigo (*Baptisia leucophaea*)
Flowering spurge (*Euphorbia corollata*)

Dominant Grass-like Plant

Sedge (*Carex cephalophora*)

149. Northwest-facing, cherty, sandstone, wooded slopes along Little Sinking Creek, sec. 26, T. 32 N., R. 3 W., two miles southwest of Bunker, Dent County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
Red maple (*Acer rubrum*)

Other Tree Associates

Black gum (*Nyssa sylvatica* var. *caroliniana*)
White oak (*Quercus alba*)

Dominant Understory

Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)
Hop hornbeam (*Ostrya virginiana*)
Ironwood (*Carpinus caroliniana*)

150. Cherty ravine floor and adjacent lower slopes in Stilwell Hollow, Low Gap Game Refuge, southeast of Black U. S. Lookout, sec. 12, T. 32 N., R. 1 E., four miles southwest of Black, Reynolds County.

Dominant Trees

White oak (*Quercus alba*)
Black gum (*Nyssa sylvatica* var. *caroliniana*)
Northern red oak (*Quercus borealis* var. *maxima*)

Other Tree Associates

Shagbark hickory (*Carya ovata*)
Black oak (*Quercus velutina*)
Scarlet oak (*Quercus coccinea*)
Southern yellow pine (*Pinus echinata*)
Red maple (*Acer rubrum*)
Sassafras (*Sassafras albidum* var. *molle*)
Butternut (*Juglans cinerea*)
Sycamore (*Platanus occidentalis*)
Slippery elm (*Ulmus fulva*)
Red mulberry (*Morus rubra*)

Dominant Understory

Hazelnut (*Corylus americana*)
Serviceberry, Juneberry (*Amelanchier canadensis*)
Flowering dogwood (*Cornus florida*)
Ironwood (*Carpinus caroliniana*)
Black haw (*Viburnum rufidulum*)
Ozark witch hazel (*Hamamelis vernalis*)
Smooth alder (*Alnus rugosa*)
Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)
Fragrant sumac (*Rhus aromatica*)
Spicebush (*Benzoin aestivale*)
Elderberry (*Sambucus canadensis*)
Alternate-leaved dogwood (*Cornus alternifolia*)
Climbing rose (*Rosa setigera* var. *tomentosa*)

Dominant Grasses and Grass-like Plants

Panic grass (*Panicum Boscii*)
Panic grass (*Panicum xalapense*)
Panic grass (*Panicum dichotomum*)
Panic grass (*Panicum lanuginosum* var. *Lindheimeri*)
Sedge (*Carex cephalophora*)

151. Woods along headwaters of Big Creek, sec. 5, T. 31 N., R. 3 W., two miles south of Melton, Shannon County.

Dominant Trees

Northern red oak (*Quercus borealis* var. *maxima*)
White oak (*Quercus alba*)

Other Tree Associates

Mockernut hickory (*Carya tomentosa*)
Red maple (*Acer rubrum*)
Scarlet oak (*Quercus coccinea*)
Sassafras (*Sassafras albidum* var. *molle*)
Winged elm (*Ulmus alata*)
Southern yellow pine (*Pinus echinata*)

Dominant Understory

Ozark witch hazel (*Hamamelis vernalis;* along stream bed)

Other Understory Associates

Juneberry, serviceberry (*Amelanchier canadensis*)
Buck brush (*Symphoricarpos orbiculatus*)
Flowering dogwood (*Cornus florida*)
Black haw (*Viburnum rufidulum*)
Winter grape (*Vitis cinerea*)

152. Cherty quartzitic slopes of ravine tributary to Huzzah Creek, two miles southeast of Davisville, Crawford County.

Dominant Trees

White oak (*Quercus alba*)
Northern red oak (*Quercus borealis* var. *maxima*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)

Other Tree Associates

Winged elm (*Ulmus alata*)
Red mulberry (*Morus rubra*)

Dominant Understory

Flowering dogwood (*Cornus florida*)

Other Understory Associates

Sassafras (*Sassafras albidum* var. *molle*)
Hop hornbeam (*Ostrya virginiana*)

Dominant Herbaceous Non-Grass Plants

Dittany (*Cunila origanoides*)
Honeysuckle (*Lonicera flava*)
Bedstraw (*Galium arkansanum*)

153. Gravelly wash in draw in upland off North Fork Hollow, near Cane Creek, sec. 8, T. 26 N., R. 4 E., six miles east of Ellsinore, south of Upalika, near Wayne County line, in Butler County.

Dominant Trees

Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Red maple (*Acer rubrum*)
White oak (*Quercus alba*)

Other Tree Associates

Mulberry (*Morus rubra*)
Shingle oak (*Quercus imbricaria*)
American elm (*Ulmus americana*)

Chief Understory

Hazelnut (*Corylus americana*)
Flowering dogwood (*Cornus florida*)
Black haw (*Viburnum rufidulum*)
Possum haw (*Ilex decidua*)
Prairie willow (*Salix humilis*)
Shrubby St. John's-wort (*Hypericum prolificum*)

154. Small gravel wash along slight gradient of ravine slope, near Cane Creek, sec. 8, T. 26 N., R. 4 E., six miles east of Ellsinore, south of Upalika, near Wayne County line, in Butler County.

Dominant Trees

White oak (*Quercus alba*)
Red maple (*Acer rubrum*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)

Other Tree Associates

Shingle oak (*Quercus imbricaria*)
American elm (*Ulmus americana*)

Dominant Understory

Possum haw, deciduous holly (*Ilex decidua*)
Dogwood (*Cornus florida*)
Prairie willow (*Salix humilis*)
Hazelnut (*Corylus americana*)
Black haw (*Viburnum rufidulum*)
Red mulberry (*Morus rubra*)

155. Lamotte sandstone bluffs along Pickle Creek, Pickle Springs, sec. 20, T. 36 N., R. 7 E., six miles northwest of Coffman, Sainte Genevieve County.

Dominant Trees

Scarlet oak (*Quercus coccinea*)
White oak (*Quercus alba*)
Southern yellow pine (*Pinus echinata*)
Black oak (*Quercus velutina*)
Red maple (*Acer rubrum*)

Dominant Understory

Farkleberry (*Vaccinium arboreum* var. *glaucescens*)
Greenbrier (*Smilax glauca* var. *leurophylla*)

156. Lamotte sandstone ravine along Pickle Creek, Pickle Springs, sec. 29, T. 36 N., R. 7 E., six miles northwest of Coffman, Sainte Genevieve County.

Dominant Trees

Red maple (*Acer rubrum*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Northern red oak (*Quercus borealis* var. *maxima*)
White oak (*Quercus alba*)
Black oak (*Quercus velutina*)
Sassafras (*Sassafras albidum* var. *molle*)
Bitternut hickory (*Carya cordiformis*)
Mockernut hickory (*Carya tomentosa*)

Dominant Shrubs

Flowering dogwood (*Cornus florida*)
Juneberry, serviceberry (*Amelanchier canadensis*)
Hop hornbeam (*Ostrya virginiana*)
Ironwood (*Carpinus caroliniana*)
Greenbrier (*Smilax glauca* var. *leurophylla*)
Smooth alder (*Alnus rugosa*)
Low-bush huckleberry (*Vaccinium vacillans* var. *crinitum*)

157. Ravine bottom woods along Coldwater Creek, sec. 33, T. 35 N., R. 8 E., three miles northeast of Womack, St. Francois County.

Dominant Trees

White oak (*Quercus alba*)
Sycamore (*Platanus occidentalis*)

Other Tree Associates

Red maple (*Acer rubrum*)
Sugar maple (*Acer saccharum*)
Shagbark hickory (*Carya ovata*)
American elm (*Ulmus americana*)
Sour gum (*Nyssa sylvatica*)

Dominant Understory

Smooth alder (*Alnus rugosa*) — Hazelnut (*Corylus americana*)

Other Understory Associates

Spicebush (*Benzoin aestivale*) — Ward's willow (*Salix longipes* var. *Wardii*)
Dogwood (*Cornus florida*)

158. Wooded floor of ravine tributary to headwaters of Brazil Creek, sec. 28, T. 38 N., R. 1 W., six miles northeast of Berryman, Washington County.

Dominant Trees

White oak (*Quercus alba*) — Bitternut hickory (*Carya cordiformis*)
Scarlet oak (*Quercus coccinea*) — Sassafras (*Sassafras albidum* var. *molle*)
Mockernut hickory (*Carya tomentosa*) — Red maple (*Acer rubrum*)

Dominant Understory

Flowering dogwood (*Cornus florida*) — Hazelnut (*Corylus americana*)

159. Slight draw on upper east-facing portion of porphyritic trachyte slopes of Little Pilot Knob, sec. 36, T. 38 N., R. 1 W., three miles northwest of Floyd, Washington County.

Dominant Trees

Southern yellow pine (*Pinus echinata*) — Northern red oak (*Quercus borealis* var. *maxima*)
Sassafras (*Sassafras albidum* var. *molle*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*) — Black oak (*Quercus velutina*)
Persimmon (*Diospyros virginiana*)

Dominant Understory

Flowering dogwood (*Cornus florida*)

160. Cherty slopes along Little Fourche à Renault Creek, sec. 2, T. 37 N., R. 1 E., two miles southeast of Floyd, Washington County.

Dominant Trees

Southern yellow pine (*Pinus echinata*) — White oak (*Quercus alba*)
Red maple (*Acer rubrum*)

Dominant Understory

Flowering dogwood (*Cornus florida*)

SUBCLIMAX STAGE C

Ulmus americana Subclimax

161. Upper, cherty portion of northeast-facing limestone slopes along St. Francis River, just west of Greenville, Wayne County.

Dominant Trees

American elm (*Ulmus americana*) — Slippery elm (*Ulmus fulva*)

Dominant Understory

Shadbush, serviceberry (*Amelanchier canadensis*) — Winged elm (*Ulmus alata*)
Hop hornbeam (*Ostrya virginiana*)

MIXED ASSOCIATIONS WHERE ONE HAS PENETRATED AND INTERGRADED INTO ANOTHER

162. Porphyritic trachyte "shut-in" along Marble Creek, sec. 21, T. 32 N., R. 5 E., two and one-half miles southwest of French Mills, Madison County.

Dominant Trees

Winged elm (*Ulmus alata*)
Scarlet oak (*Quercus coccinea*)
White oak (*Quercus alba*)

Other Tree Associates

Southern yellow pine (*Pinus echinata*)
Red cedar (*Juniperus virginiana*)
Northern red oak (*Quercus borealis* var. *maxima*)
Mockernut hickory (*Carya tomentosa*)
River birch (*Betula nigra*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
American elm (*Ulmus americana*)
Red maple (*Acer rubrum*)

Dominant Understory

Ozark witch hazel (*Hamamelis vernalis*)
Smooth alder (*Alnus rugosa*)
Swamp dogwood (*Cornus obliqua*)
Greenbrier (*Smilax Bona-nox*)
Sycamore (*Platanus occidentalis*)
Greenbrier (*Smilax glauca* var. *leurophylla*)

163. Porphyritic trachyte slopes along St. Francis River, sec. 10, T. 32 N., R. 5 E., two miles north of French Mills, Madison County.

Dominant Trees

Sugar maple (*Acer saccharum* var. *glaucum*)
Red maple (*Acer rubrum*)
Sour gum (*Nyssa sylvatica* var. *caroliniana*)
Sweet gum (*Liquidambar Styraciflua*)
Northern red oak (*Quercus borealis* var. *maxima*)
Linden (*Tilia glabra*)
Red mulberry (*Morus rubra*)
White oak (*Quercus alba*)
Winged elm (*Ulmus alata*)

Dominant Understory

Flowering dogwood (*Cornus florida*)
Pawpaw (*Asimina triloba*)
Ironwood (*Carpinus caroliniana*)
Hop hornbeam (*Ostrya virginiana*)
Bristly greenbrier (*Smilax hispida*)
Greenbrier (*Smilax Bona-nox*)

164. Porphyritic trachyte slopes along "shut-in" of Telleck Branch, sec. 23, T. 35 N., R. 1 E., three and one-half miles northwest of Shepherd, Iron County.

Dominant Trees

Southern yellow pine (*Pinus echinata*)
Red cedar (*Juniperus virginiana*)
Sugar maple (*Acer saccharum* var. *glaucum*)
White oak (*Quercus alba*)
Winged elm (*Ulmus alata*)
Northern red oak (*Quercus borealis* var. *maxima*)
Black gum (*Nyssa sylvatica* var. *caroliniana*)
Red maple (*Acer rubrum*)
Persimmon (*Diospyros virginiana*)

Dominant Understory

Indian cherry (*Rhamnus caroliniana*)

THE LIBRARY OF THE
JAN 22 1941

UNIVERSITY OF ILLINOIS-URBANA
580.5FB C001
FIELDIANA, BOTANY$CHICAGO
9
3 0112 009379238